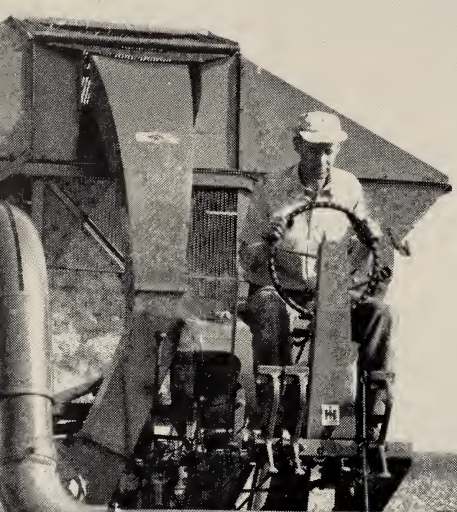
Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA



Economics of MECHANICAL COTTON HARVESTING

TRIMBLE R. HEDGES
WARREN R. BAILEY

A Report of Studies Made in the San Joaquin Valley of California

CALIFORNIA AGRICULTURAL EXPERIMENT STATION

BULLETIN 743

Machines picked more than 16.2 per cent of California's 1,268,000-bale cotton crop in 1949. This bulletin presents the findings obtained from interviews with 63 San Joaquin Valley cotton growers, each of whom owned and operated one mechanical cotton picker during that year. The study was undertaken to determine the range of situations in which mechanized cotton harvesting is economically sound.

Mechanical cotton picking was found to be practicable and profitable when

Acreage is 100 acres or more,
Yield is 1 bale per acre or more, and
Full-season use is made of the machine.

Typical operation was estimated as:

Full season = 60 working days, or 500 hours
Acreage = 200 acres of 1.5-bale cotton
Yield = 300 bales

Total economic costs of machine picking were computed, analyzed, and compared with the cost of hand picking in a wide variety of situations. Total economic cost includes:

Labor
Overhead and operating expenses
Field waste
Reduced sale value, due to reduction in quality

In all cases where the basic requirements of acreage, yield, and use of the machine were met, machine harvesting was advantageous. When total economic costs of the 1949 crop were added up and compared, it was found that

Per bale, hand picking averaged	$45.00
machine picking averaged	25.76
Saving	$19.24

Mechanical cotton pickers can be operated most efficiently and grade loss kept at a minimum if cotton is planted and fields are cared for with mechanical harvesting in mind. The grower should

Space rows 40 inches apart
Make the stalk-row ground higher than that between rows
Plant stalks 4 to 8 inches apart
Keep fields clean of weeds and grass
Keep the ground surface smooth and free of clods

The Long-Range View

1949 was a year of prosperous conditions and high employment. The advantage of machine over hand harvesting, in the average situation, was considerable. To determine the advantage, if any, when wage costs are lower compared with machine costs, 1938, a year of less prosperous conditions and intermediate employment, was selected as a basis for comparison. When 1949 machine-harvesting costs were converted to 1938 prices, it was found that savings, while less, would still be real and substantial.

CONTENTS

THE AUTHORS:

Trimble R. Hedges is Associate Professor of Agricultural Economics, Associate Agricultural Economist in the Experiment Station and on the Giannini Foundation, Davis.

Warren R. Bailey is Agricultural Economist, Production Economics, Research Branch, Agricultural Research Service, United States Department of Agriculture, Washington, D.C.

Assistance in collecting the data and in certain phases of the analysis was provided by Chester O. McCorkle, Jr., Assistant Professor of Agricultural Economics, Assistant Agricultural Economist in the Experiment Station and on the Giannini Foundation, Davis.

APRIL, 1954

Economics of MECHANICAL COTTON HARVESTING

TRIMBLE R. HEDGES • WARREN R. BAILEY

A Report of Studies Made in the San Joaquin Valley*

SUMMARY

CALIFORNIA GROWERS are rapidly mechanizing their cotton picking. Between 1946 and 1951 the number of machines increased from 25 to 3,700, and the portion of the crop picked by machine increased to 54 per cent. With this rapid development of a new harvesting method many technical and economic problems have arisen. The economic costs of harvesting cotton mechanically as compared with those of hand harvest include: 1) the cost of machine picking; 2) the reduction (if any) in grade and value of the cotton; and 3) the additional field waste (if any) attributable to the machine. This study was undertaken to get information on these factors and to determine the range of situations in which mechanical cotton harvesting is economically feasible.

Information on use of machines, cost of picking, and gin turnout was obtained by interviews with 63 growers who used machines in 1949. Data on grade and value of machine- and hand-picked cotton were obtained from representative gins for three seasons, 1948 to 1950. Estimates of field waste from each method of picking were based on experimental work at the Shafter Cotton Field Station.

In 1949 machine picking did not begin in the San Joaquin Valley until mid-October, when about a fifth of the cotton crop had already been picked by hand. The average use and output of the 63

* Submitted for publication May 25, 1953.

Table 1. Average Use and Output of 63 Mechanical Harvesters During 1949 Season

	First pick	Second pick	Total season pick
Days operated	26	21	47
Hours operated	243	164	407
Acres picked	145	139	284
Bales picked	182	47	229
Hundredweight seed cotton	2,482	701	3,183

Table 2. Average Performance Rates per Hour and per Day, 1949

	First pick	Second pick	Total season pick
Acres picked per hour	0.60	0.82	0.70
Pounds of seed cotton per hour	1,021.00	429.00	782.00
Bales picked per day	7.00	2.30	4.90

mechanical harvesters for that season are shown in table 1.

Use and therefore output per harvester varied considerably from farm to farm because some growers who were using machines for the first time did not attempt first picking. Others used machines merely to supplement hand picking or bought machines after the season had begun. Thirty-one machines were used at full season's capacity. They picked an average of 292 bales on 356 acres of picking in 520 hours of operation. From this, a grower can expect a machine to harvest completely 200 acres (150 acres picked a second time) or about 300 bales of cotton in a typical season.

Growers reported they had fewer breakdowns and kept their machines operating more of the time in 1949 than in previous years because they understood better the mechanical requirements. Some moderate improvement can be expected in the performance rates shown in table 2.

Gin turnout of machine-picked cotton was 36.5 per cent. This was less than one percentage point below the turnout of hand-picked cotton. It required 1,370 pounds of machine-picked seed cotton, compared with 1,348 pounds of hand-picked, to turn out a 500-pound bale of lint. Turnout of the machine-picked cotton was relatively low early in the season; it equaled the hand-picked in mid-season; and it was actually higher than the turnout of hand-picked cotton in late-season picking.

Cost of machine picking (excluding grade loss and field waste) for the 63 growers in 1949 averaged $14.65 per bale harvested, $11.72 per acre of picking, and $8.25 per acre of machine operation. Highest cost per bale, $20.72, was in the Madera-Merced area where an average of only 158 bales was picked per machine. The lowest cost, $11.71, was in Westside where the average was 292 bales per machine.

Overhead items dominate the cost picture. Cost per bale included $7.57 for overhead on harvester and tractor, $4.43 for operating expenses, and $2.64 for labor. The purchase price of approximately $9,500 (in 1949) for harvester and tractor largely explains the high overhead costs. Annual depreciation charges were $1,483, and annual interest on investment was $217 for the equipment.

The average cost of $14.65 a bale was based on a season pick of 229 bales (somewhat less than full machine capacity in the Valley) and a service life of five years for the harvester (somewhat less than farmers can reasonably expect today). Therefore, the cost of picking was recalculated for a season pick of 300 bales and a service life of six years. On that basis, the cost of picking would be $12.29 a bale.

Since overhead is a major item of cost, full use of the machine is important. The effect of annual use on cost of picking per bale (in 1.5-bale cotton) was calculated as shown in the table at the top of page 6.

When annual use is:		*Picking cost*
acres	*bales*	*per bale is:*
50	75	$21.55
100	150	$14.94
150	225	$13.04
200	300	$12.29
300	450	$11.91

When season use falls below 100 acres, the cost rises sharply, but pushing use beyond 200 acres results in only small additional savings. One hundred acres seems to be the minimum for which it pays a grower to own a harvester. With less than 100 acres, he can better afford to hire custom machine picking.

The effect of yield on cost of machine picking per bale, when a harvester operates 500 hours a season, would be:

When yield per acre (in bales) is:	*Picking cost per bale is:*
0.75	$20.15
1.25	$13.56
1.75	$11.32
2.25	$10.28

The interrelationship of yield and season use as it affects cost of machine picking per bale is shown in table 3. If the yield is high, the picking cost per bale is reasonable even though the season pick is only 100 acres. If yield is low, the cost is comparatively high even though the season pick is 300 acres.

Second picking, especially near the end of the season, often is very light. Whether this "scrapping" should be picked by hand, by machine, or not at all is an economic question that faces many farmers. Hand picking, in this situation, often costs $4.00 or more per 100 pounds of seed cotton. The cost of machine picking varies with the pick per acre as shown in table 4. If the grower includes overhead in his machine-picking cost, he would find machine picking less economical than hand picking when the pick is 150 pounds or less. If he considers only the direct operating costs, costs of both methods would be about equal when the pick is around 100 pounds.

Reduced grades of lint cotton represent one of the economic costs of ma-

Table 3. Interrelationship of Yield and Season Use as it Affects the Cost of Machine Picking

Season pick	Cost per bale	
	1-bale cotton	2-bale cotton
100 acres	$ 20.96	$ 12.22
300 acres	15.71	10.39

Table 4. Cost of Machine Picking in Relation to Pick of Seed Cotton per Acre

Pick per acre, in pounds	Machine-picking cost per 100 pounds	
	Total costs	Operating costs
50	$15.48	$ 9.64
100	7.81	4.86
150	5.21	3.24
200	3.94	2.46

chine picking. Machine-picked cotton in the 1949 season averaged slightly less than one full grade below hand-picked. Thus, machine bales were concentrated in the grade of Strict Low Middling and hand bales in Middling. Consequently, the machine-picked cotton averaged lower in value. The average government loan value was $132.52 a bale for the machine-picked and $142.84 for the hand-picked, a difference of $10.32 a bale. The difference was $19.75 a bale in the Madera-Merced area, but only $8.06 a bale in Westside. This variation between areas was doubtless due mainly to differences in cotton, weed conditions, and experience of machine operators.

The difference in grades and values also varied widely among gins. Even in Westside, where machine-picked cotton more nearly approached the hand-picked in grade, the difference ranged from $13.34 a bale at one gin to $1.47 at another. The variation among gins was probably due to differences in equipment and experience of the gin operator with machine-picked cotton.

Grades of machine-picked cotton also varied widely among growers in each subarea. But in each, at least one grower had seasonal average grades of Strict Low Middling or better. This suggests that good grades can be obtained with machine picking in all parts of the Valley, but that more careful operation is required in some areas.

Seasonal trends in grades of machine-picked and hand-picked cotton at eight gins located in various parts of the Valley show that machine-picked cotton averaged lower in grade throughout the season. But the spread between grades

Figure 1. Transferring the seed cotton from the picker basket to a cotton trailer. Capacity of the basket is about 750 pounds of seed cotton, or the equivalent of about one-half bale.

tended to narrow in late-season picking, and the week-to-week fluctuations in grade were smaller in the hand-picked than in the machine-picked cotton.

Although experimental results have shown that mechanical picking was 1.1 percentage point less efficient than hand picking, it is assumed that under general farm conditions the disparity would be 3.0 percentage points. Thus, in 1.5-bale cotton, a mechanical picker would leave 69 pounds more seed cotton per acre. The field value of that much seed cotton in 1949 was about $4.73; it amounted to about $3.15 per harvested bale. This additional field waste caused by the machine is an economic cost of mechanical harvesting when compared with hand harvesting. Most growers said machines "now clean the fields" more thoroughly than in previous years; few were still concerned about field waste. They reported that field waste was relatively smaller in rank-growing, high-yielding cotton.

The economic advantage or disadvantage of machine picking is found by adding together the costs of picking, value of grade loss, and value of field waste and comparing the sum with the cost of hand harvesting. For this purpose, the recalculated cost of picking, $12.29 per bale, representing full use and a six-year service life of the harvester, is used. It is assumed that cost of hand harvesting is $45.00 per bale (as in 1949) and that the average yield is 1.5 bales an acre. The total economic cost of machine picking includes $12.29 for picking, $10.32 for grade loss, and $3.15 for field waste, a total of $25.76 per bale, which represents a saving of $19.24 over hand harvesting. This saving in economic costs varied among the subareas according to differences in grade loss (table 5).

Cost of picking with a less widely used, newer make of machine harvester was also obtained by interviews with 18 growers for the 1950 season. The information obtained was deemed inconclusive because this make of machine had been used commercially in the Valley for such a short time. Data suggest, however, that growers using this machine also found their picking cost well below the cost of hand picking.

Table 5. Average Savings of Machine Harvesting in the Five Subareas of the San Joaquin Valley

Area	Economic cost of machine harvesting per bale	Saving over cost of hand harvesting per bale
Kern	$ 26.29	$ 18.71
Eastside	30.16	14.84
San Joaquin–Tranquillity	27.12	17.88
Westside	23.50	21.50
Madera–Merced	35.19	9.81

INTRODUCTION

Mechanical cotton pickers began to find acceptance in California in 1945, although a few machines had been used in field trials as early as 1943 and 1944. In 1945 Venstrom (1946) noted 20 machines operating in the south and Westside of the San Joaquin Valley. Progress was slow at first, and two years later only 75 machines were being operated. By 1948, however, some 475 harvesters were in use, and the possibilities of mechanizing the harvest looked more promising. Mechanical picking came of age in 1949 when more than 16.2 per cent of a 1,268,000-bale crop was machine picked. Information for 1951 indicates that an estimated 3,700 machines picked more than half of the 1,800,000 bales of California cotton (table 6). Although mechanization of the California cotton harvest is approaching full realization, many technical and economic problems remain to be solved.

The 1949 season proved to many growers that mechanical cotton picking is practicable and profitable. Improvements in machines, in operating techniques, and in growing the cotton crop have made successful machine harvesting possible. Individual growers had used mechanical pickers in previous years with varying degrees of success. Some said that high field waste and low grades made machine harvest economically impracticable; others claimed unqualified success. Obviously, the true situation for most growers would be somewhere between these two extremes.

The study upon which this report is based was undertaken to determine the range of situations in which machine cotton harvesting is economically feasible. Information for the study was drawn from many sources. Following the 1949 harvest season, enumerators interviewed 63 growers selected at random from among those who owned and operated *one* mechanical harvester. The machines were all one-row spindle type, mounted on a standard rubber-tired, general-pur-

Table 6. Mechanical Cotton Picking in California, 1945–1951

Year	Total harvest*		Mechanical harvesters in use‡	Machine picking†		
	Acres	Bales		Average bales per machine	Total bales picked	Percentage of crop
	thousands				thousands	
1945	317	353	20§	150	3	0.8
1946	358	458	25	175	4	1.0
1947	534	772	75	200	15	2.2
1948	804	968	475	195	93	9.6
1949	957	1,268	900	229	205	16.2
1950	581	978	1,450	221	310	31.7
1951	1,331	1,800	3,700‖	264	975	54.2

* Reported by the California Crop and Livestock Reporting Service, Sacramento.
† Estimates based on information furnished by ginning companies, data collected in earlier studies (Venstrom, 1946; Burlingame and Bailey, 1948), and other information developed by the authors.
‡ Estimates based on number of machines distributed by dealers and the estimated number purchased outside and shipped into the state.
§ It is reported that 5 machines were observed operating in 1943.
‖ Includes about 400 machines shipped into the state for custom harvesting.

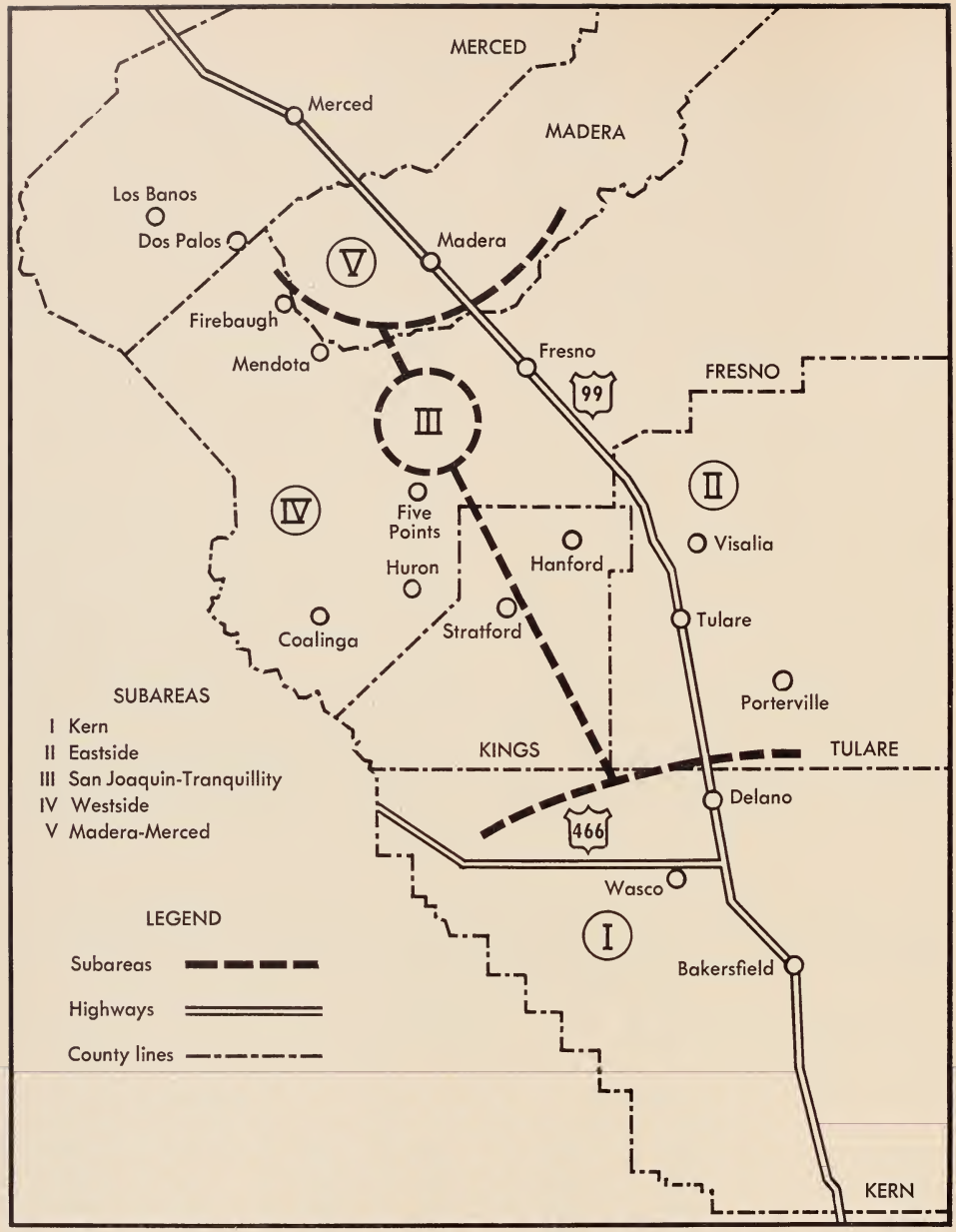


Figure 2. Subareas of the San Joaquin Valley included in studying mechanical cotton harvesting, 1949. (The 63 growers interviewed were located in these five subareas.)

pose tractor. These machines studied in 1949 are identified as Mechanical Harvester Number 1. Growers interviewed were located in five subareas considered representative of typical production situations in the San Joaquin Valley. These subareas, as defined on the map, are identified by geographic names, which henceforth are used in this report (fig. 2). Information furnished by the growers included the number of hours machines were operated, pertinent costs,

and man-hours. Data were also taken from growers' gin statements regarding weight of seed cotton, weight of lint, and bale numbers. This information helped to identify the exact grades of each lot of cotton whether machine- or hand-picked. It also permitted a comparison of gin turnout and lint grades of cotton harvested by the two methods.

Data were collected in 1950 from 18 operators of another kind of mechanical cotton harvester, here identified as Mechanical Harvester Number 2. Twelve machines were one-row, tractor-mounted, while six were two-row, self-propelled. These data were analyzed similarly to the 1949 data for Mechanical Harvester Number 1. Two other makes of mechanical cotton pickers were also being used on a very limited scale in the Valley. Neither make was included in this study because fewer than a dozen of either were in use in 1950.

The effect of machine picking on lint cotton grades was further studied by analyzing the grades of machine- and hand-picked cotton obtained from representative gins for each of three seasons, 1948–1950. The 1949 data were considered in greater detail to ascertain varia-

Table 7. Average Acres of All Land, Irrigated Land, and Principal Crops on Selected Farms Using Mechanical Cotton Pickers, San Joaquin Valley, 1949

Item	San Joaquin Valley	Subareas				
		Kern	Eastside	San Joaquin–Tranquillity	Westside	Madera–Merced
	Number of farms					
	63	15	15	9	9	15
	Average acres per farm					
Cotton	349	290	304	242	645	340
Grain*	210	....	38	70	1,196	86
Alfalfa hay	62	49	70	8	38	103
Potatoes†	17	44	26	....	....	....
Rice‡	22	....	....	26	104	13
Flax	5	....	....	....	32	....
Sugar beets	2	....	....	....	....	9
Orchard	11	18	18	....	....	8
Pasture	5	....	17	....	1	3
Fallow	61	1	4	30	388	....
Miscellaneous§	25	7	25	13	40	56
All irrigated land	769	409	502	389	2,444	615
Other land in farms‖	19	3	54	....	19	16
Total land in farms	788	412	556	389	2,463	631

* Mostly barley.
† Mostly early potatoes.
‡ Some acreage planted as first crop in land reclamation.
§ Mostly onions and milo in Kern; milo in Eastside; melons in Westside; vegetables in Madera–Merced.
‖ Includes some range pasture.

tions in grade loss among subareas in the valley. They were also analyzed at a few gins to ascertain week-by-week trends in grades during the season.

Growers interviewed in all subareas had sizable cotton operations. In 1949 the average acreage of cotton per farm varied from 242 in San Joaquin-Tranquillity to 645 in Westside. The average for all growers interviewed in the San Joaquin Valley, where practically all California cotton was grown in 1949, was 349 acres (table 7). Total land operated varied from 389 acres in San Joaquin-Tranquillity to 2,463 in Westside and averaged 788 per farm for the Valley. Grain and rice were important in the farming systems of cotton growers in Westside, grain occupying almost twice as much land as cotton. Potatoes and alfalfa hay were also found on many farms in Kern and Eastside and alfalfa in Madera-Merced (table 7).

The proportion of irrigated land in cotton on these farms varied from one-fourth in Westside to three-fourths in Kern and averaged slightly under one-half for the San Joaquin Valley.

EFFECTIVENESS OF MAN LABOR IN COTTON PRODUCTION*

Economic literature concerning cotton production in the United States abounds with references to its relatively high labor requirements. This is not surprising, inasmuch as cotton annually ranks first or second in gross value among cash crops produced in the United States, is the major field crop requiring most labor in total and per acre, and constitutes the principal, in many cases the only, source of cash income for a large proportion of farmers. Economists and other research workers have recognized the entire process of cotton growing as a heavy user of labor. Harvesting in particular, however, has received close attention because of both its weight in total labor requirements and its seasonal concentration.

The Situation prior to 1940

A cross-section evaluation of cotton labor requirements for harvesting and for the total production process is available in Holley and Arnold's report (1938). That report is particularly useful in that it preceded the commercial development of the mechanical picker and the spread of mechanization in cultural operations throughout the cotton-producing areas. It also combines the 1938 data for various areas with a digest of earlier information.

Data for four selected seasons—1909, 1919, 1929, and 1936—indicate that there was serious need to improve the effectiveness of labor in cotton production (table 8). Man-labor requirements, at 114 to 131 hours per acre, were extremely high in the older, more humid sections, and even the semiarid section, with 27 to 39 hours required, compared favorably only by contrast. Harvest labor accounted for approximately 40 to 60 per cent of all labor. Only in the semiarid areas was there evidence of a significant trend toward decreases in total labor requirements. There was no evidence of any decrease in harvesting labor requirements other than in the semiarid areas, where the practice of "snapping" rather than picking the crop was largely responsible. A limited use of "strippers" was involved as well. Reductions in preharvest labor were also evident only in the semiarid section. This was attributed to the joint influence of a level terrain, which was more favorable to mechanization, and limited rainfall, which reduced the incidence of weeds.

Holley and Arnold summarized the situation in 1938 and simultaneously underscored the strategic importance of

* This section constitutes a review of literature.

Table 8. Labor Requirements for Cotton Production by Regions 1909–1936, Selected Survey Data

Region and year	Yield of lint per acre	Man-labor per acre			Total man-labor per bale	Harvest labor per hundredweight of lint
		Preharvest	Harvest	Total		
1	2	3	4	5	6	7
	pounds	hours				
Coastal Plain:						
1909	231	66.2	53.9	120.1	252	23.3
1919	209	66.8	47.7	114.5	263	22.8
1929	196	65.4	44.3	109.7	264	22.6
1936	239	65.0	53.5	118.5	237	22.4
Mississippi Delta:						
1909	224	65.3	51.5	116.8	246	23.0
1919	227	65.6	52.0	117.6	247	22.9
1929	252	63.3	57.6	120.9	229	22.8
1936	302	62.1	68.7	130.8	210	22.7
Western, semiarid:						
1909	127	17.2	21.4	38.6	147	16.8
1919	163	15.6	17.9	33.5	97	11.0
1929	142	13.1	13.9	27.0	92	9.8
1936	176	11.7	14.9	26.6	72	8.5

Source:
Columns 1 to 6: Holley, W. C., and Lloyd E. Arnold. Changes in Technology and Labor Requirements in Crop Production—Cotton. W. P. A., National Research Project Report A-7, 1938, Table 28, p. 99.
Column 7: Calculated by the authors of this report.

improved harvesting technology as follows:

A primary obstacle to the extended mechanization of preharvesting operations is the peak labor requirements for harvesting operations. The development of the mechanical cotton picker raises prospects for overcoming this impediment. It is believed that machines now under development warrant expectations of their adoption during the next decade. They are especially adaptable to use on the relatively level lands favorable to use of tractors, and they are likely to be used there first.

Developments 1941–1950

Cotton producers have shared in the increased productivity of United States farmers since 1940. Both preharvest and harvesting labor requirements have been reduced. The increased labor efficiency has not been uniform, however, either among all cotton-producing sections or among all producers in any given section.

The first appreciable reduction in labor requirements occurred in the semiarid regions of Oklahoma and Texas. Holley and Arnold (1938) recorded the beginning of this reduction in preharvest requirements and the associated factors. The change-over from picking the lint from the open boll to hand "snapping" both boll and lint was largely responsible for the early reduction in harvesting labor requirements. This change, in turn, was associated with improved ginning equipment, which made it possible to remove the increased amount of dirt and trash harvested with the lint.

The cotton stripper was the next logi-

cal development. This is a mechanical device that removes boll and lint, much as the hand laborer does in snapping. Campbell (1948) in Oklahoma, Williamson and Rogers (1949) in Texas, and Sutherland and James (1948) in North Carolina have reported on the use of these machines.

The Oklahoma report is based on interviews in 1948 with a broad cross section of cotton growers and their suppliers. A total of 104 tractor-mounted, factory-built strippers was reported, chiefly in western Oklahoma. It was also estimated that 50 to 100 additional locally made machines were in use. Campbell found that farmers did not consider field waste and grade loss serious but did express concern about the problems caused by green bolls and leaves. Bales harvested during the season ranged from 1 to 75 and averaged 22 per machine. The author did not attempt a conclusive financial analysis but indicated that stripping appeared profitable in 1947. Apparently, harvesting required about one hour per acre, and stripper operators were willing to do custom work at about $1.50 per 100 pounds of seed cotton, as compared with $2.00 to $2.50 for hand snapping.

The Texas report included data for 64 farms using strippers in 1948. Williamson and Rogers obtained data on both dry-land and irrigated farms but found that use of the stripper on the latter was limited largely to "scrapping" after hand harvesting. Dry-land farmers, in contrast, stripped 45 per cent of their acreage. Field waste averaged 9 and 14 per cent, respectively, for storm-resistant and normal boll varieties on dry-land farms. Comparable figures for irrigated land were 6 and 13 per cent. Grade loss also was appreciable. The season's average value of a bale of cotton was $127 for hand-snapped and $116 for stripped cotton. Williamson and Rogers also analyzed operating costs. Their findings for total cost of harvesting and hauling to

Table 9. Cost of Operating Mechanical Cotton Strippers, High Plains, Texas, 1948*

	Dry land		Irrigated land	
	Per acre	Per bale	Per acre	Per bale
No hand snapping:				
Variable cost	$1.55	$ 7.77	$ 2.33	$ 3.10
Labor	(0.91)	(4.54)	(1.15)	(1.55)
Other	(0.64)	(3.23)	(1.18)	(1.55)
Fixed cost	0.91	4.55	0.91	1.21
Total	$2.46	$12.32	$ 3.24	$ 4.31
After hand snapping:				
Variable cost	1.46	13.18	1.66	6.83
Labor	(0.83)	(7.50)	(0.91)	(3.75)
Other	(0.63)	(5.68)	(0.75)	(3.08)
Fixed cost	0.91	8.19	0.91	3.75
Total	$2.37	$21.37	$ 2.57	$10.58

Source: Williamson, M. N., Jr., and Ralph H. Rogers. Economics of Cotton Harvesting, Texas High Plains, 1948 Season. Texas Agr. Exp. Sta. Progress Report 1200, 1949.
* Does not include consideration of grade loss and field loss.

the gin are summarized in table 9. The cost of hand snapping plus hauling was estimated at $31.50 and $36.00 per bale, respectively, on irrigated and dry-land farms before the first frost of the season. Costs increased after the first frost. Comparative costs for labor are important, as most of the cost of hand snapping is for labor.

Grade loss was a major item in total cost of mechanically stripping cotton in North Carolina. Sutherland and James (1948), making comparisons with the value of hand-picked cotton, found lowered grade responsible for $29.90 of the total cost of $38.62 per bale. Here, as in Texas, however, hand snapping was more costly. A smaller grade loss, $24.35 per bale, was more than offset by the higher labor cost, and the total cost of hand snapping averaged $61.35 per bale.

Mechanical cotton pickers of the spindle type were first released in 1941 when 12 were sold (Archer, 1948). In subsequent years sales were as follows: 12 in 1942, 15 in 1943, 25 in 1944, and 75 each year from 1945 through 1947. Volume production of these machines was scheduled for 1948. Mechanical pickers of this type were operating in the major cotton-producing sections by 1945, though still in small numbers.

Growers in California and the Mississippi Delta have led in buying and using the spindle-type mechanical picker. Venstrom (1946) reported for California: "By 1945 some twenty-odd machines were in operation in the State." Interviews with nine operators regarding their 1945 experience led him to conclude that "operators of the larger cotton acreages in California have accepted the mechanical cotton picker." (This inference seems to have been somewhat optimistically premature, for later studies showed that many of the larger growers in 1948 and 1949 were still using much hand labor in the cotton harvest.) Venstrom reported that on a "once-over" basis for 500 acres, the mechanical picker could pick at a cost of $1.57 per 100 pounds of seed cotton, or $22.00 per 500-pound bale of lint. These figures were based on prices of cotton lint at 22 cents per pound, 10 per cent field waste, and one grade loss in quality. They compared with costs of hand picking at $2.40 to $2.70 per 100 pounds, or $32.00 to $37.00 per bale in 1945. Substantially comparable data were obtained from a limited number of machines studied three years later in the San Joaquin Valley.

A sharp increase in mechanical picking of California cotton was noted by Burlingame and Bailey (1950): "Several hundred growers have bought machines and in the 1949 season probably 15 per cent of the cotton was machine-picked." The authors based their economic analysis on the 1948 experience of ten growers in Fresno and Kern counties. These cooperators owned 23 machines that harvested 4,500 bales in 1948. On the average, each machine picked cotton equivalent to 1,500 man-days of hand picking at a cost of $2.14 per 100 pounds of seed cotton. These costs, on a per-bale basis, included $16.62 for machine overhead and operation, $5.99 for field waste, and $7.37 for grade loss—a total of $29.98 as compared with a hand-picking cost of $45.00. The performance record of the machines in this study is noteworthy: "On the average each machine operated 58 working days, picked 244 bales or 3,434 hundredweight of seed cotton, and covered 313 acres (once over)."

Sutherland and James (1948) included data on four mechanical pickers in their 1948 progress report from North Carolina. The season's use of the mechanical pickers averaged 44 bales harvested from 60 acres at a total field-operating cost of $19.69 per acre and $26.70 per bale. The authors point out: "Data on mechanical pickers are not adequate to draw conclusions but they appear to have possibilities if 100 or more bales can be picked per machine

Table 10. Performance and Costs for Mechanical Cotton Picker in Mississippi, 1945–1947

Item	1945	1946	1947
Number of pickers studied	27	20	26
	bales		
Bales harvested			
Per picker	111.0	87.0	109.0
Per day	4.0	2.0	3.5
Selected cost items			
Variable cost:			
Labor	$ 258.74	$ 454.17	$ 337.92
Repairs	173.44	477.27	431.52
Other	114.64	162.35	187.99
Total	$ 546.82	$1,093.79	$ 957.43
Fixed cost:			
Depreciation, picker	501.08	505.95	516.31
Other	128.46	129.48	132.15
Total	$ 629.54	$ 635.43	$ 648.46
Operating cost per bale			
Variable cost	4.92	12.51	8.81
Fixed cost	5.66	7.27	5.96
Total	$ 10.58	$ 19.78	$ 14.77

Source: Crowe, Grady B. Mechanical Cotton Picker Operation in the Yazoo-Mississippi Delta. U. S. Bureau of Agricultural Economics, Miss. Agr. Expt. Sta. Progress Report 1949, Tables 1, 2, and 8, pp. 6, 7, and 8

during the year." The findings in this report concerning harvesting costs per bale are important even though lack of data prevented a complete analysis including field waste and grade loss for the mechanical picker. Hand picking was figured at $3.00 and hand snapping at $2.00 per 100 pounds of seed cotton (and trash).

Experience with mechanical pickers in Mississippi is reported by Crowe (1949*a*, 1949*b*). His data covered the three seasons 1945–1947. It was estimated that by 1948 there were 600 to 650 of the spindle-type mechanical pickers in the Delta area alone. Some of the salient data concerning strictly field-harvesting operations that resulted from Crowe's analysis are listed in table 10.

The influence of increasing the number of bales picked per machine on reducing costs per bale is emphasized in his report. Higher prices for the mechanical harvester have the opposite influence—increasing costs per bale. An evaluation was also made of the effects of field loss and grade deterioration accompanying machine picking. The average field loss of 8 per cent in 1947 was figured at $13.00 and the loss in grade at $7.90 per bale, a total of $20.90 added to the cost of machine picking as compared with hand methods. This meant, at 1947 prices, a total cost of $35.67 per

bale, or $2.42 per hundredweight of seed cotton (table 10). Hand-picking rates, meanwhile, ranged from $2.50 to $4.50 per 100 pounds of seed cotton. Finally, the Crowe report recognizes problems concerning defoliation, weeds and grass, lack of properly equipped gins, and the need for competent mechanical operation.

The Situation in 1949

The present study was undertaken more than ten years after the Holley and Arnold report had focused attention on the inefficiency of labor in cotton production in the United States. Meanwhile, World War II had come and gone, resultant shortages of labor and changing price relationships demanded the substitution of capital and machines for human energy, and the postwar world need for cotton had melted away the cotton surpluses of the 1930's.

The findings of the research studies reviewed may be summarized in the following key points describing the situation at the beginning of 1949:

1. Interest in mechanizing the cotton harvest had resulted from the relatively low effectiveness of hand labor in the cotton harvest and the consequent heavy requirements for both harvest and total labor.

2. Mechanical strippers had proved economic at postwar prices in the semi-arid areas but had not found a place in California.

3. The spindle-type mechanical cotton harvester had been used widely in the Mississippi Delta and in California.

4. Relatively heavy investments and overhead costs were involved in owning the current models of mechanical cotton pickers.

5. Volume of use in terms of total bales harvested annually was a major factor affecting harvester operating cost per bale, largely because of overhead costs.

6. Field waste of seed cotton not recovered by the picker was considered an important cost in mechanical picking.

7. Grade deterioration was also recognized as a major economic cost in mechanical picking.

8. More experience was needed before it would be possible to define precisely the range of conditions within which it is economic to own and operate a mechanical cotton picker.

It is evident that an appraisal of progress in mechanizing the cotton harvest must be comprehensive, that it must concern itself with all economic aspects of the question. Total cost of mechanical picking includes overhead and operating expenses, field waste, reduced sale value of cotton due to quality reduction, and any added ginning, hauling, or other incidental expense. All these must be considered in a complete evaluation. It is also evident from the literature that scale of operations, price levels for cotton and cottonseed, relative prices for labor and other operating items, yields per acre, and the probable pattern of weather during the harvest period are factors that must be recognized. So far as possible, the nature and extent of influence by these factors should be identified and measured. It is appropriate and highly important, finally, to establish certain guiding principles concerning the use of mechanical cotton pickers by farmers operating on various scales.

The present study was timed to assemble and evaluate a representative picture from the experience of California farmers with the mechanical picker. It is limited to farmers owning one picker.

USE AND PERFORMANCE OF MECHANICAL HARVESTERS

Before 1949 many growers had considered machine harvesting as merely supplemental to hand picking. A number of machines had, therefore, been used only in second picking when workers were unavailable, or sometimes in fields too weedy or too low in yield to attract workers. The lack of a successful chemical defoliant also tended to discourage machine picking until after the first heavy frost.* Thus, there had been no widespread effort to make maximum use of harvesting machines. A considerable number of operators, however, did make reasonably full use of mechanical pickers during the 1949 season. The results of the experience are reported herein for 63 such growers interviewed in early 1950.

Summary of machine use

A typical grower began machine harvesting on October 19 and finished on January 1. He operated his machine 47 working days during this 75-day period for a total of 407 machine-hours.† He covered a total of 284 acres once over, 145 acres of first picking and 139 acres of second picking. He picked a total of 229 bales, of which 182 bales were first picking and 47 were second picking. The average machine picked 3,183 hundredweight of seed cotton, equivalent to the amount 25 hand workers could have picked in 50 working days.

Figure 3. A rear view of a mechanical cotton harvester picking cotton.

Mechanical pickers on the average were operated more hours (479), covered more acres (317), and picked more bales (292) in Westside than in any other area. Machines were used least in the northern area where they did the least first picking.

Amount of use per machine varied considerably. Total days operated ranged from 16 to 112, machine-hours from 120 to 766, acres of picking from 80 to 535, and bales picked from 93 to 613. As might be expected, some machines operated less than a full season whereas others operated at near capacity. Study of the 63 individual records revealed that 31 machines operated an average of 520 hours in 62 working days between October 11 and January 7. They picked an average of 292 bales from 356 acres, 182 acres of first picking and 174 acres of second picking.

All but four of the 63 growers used their machines in first picking, and all but two growers did some second picking. Eleven growers machine picked all their cotton, averaging 263 bales, of which 235 were first picking and 28 were second picking. These growers had, on the average, 158 acres of cotton, of which they second picked 110 acres.

* Climate and Man. Yearbook of U. S. Department of Agriculture. The average date of the first killing frost in the fall is November 25 at Bakersfield, November 14 at Hanford, November 15 at Coalinga, December 1 at Fresno, and November 16 at Madera.

† Machine-hours exclude morning, noon, and evening service time and extended stops for adjustments or repairs but include stops for minor adjustments or repairs, for unloading the basket, and for resting the operator.

Summary of performance rates

The number of acres the harvester picks per day depends upon the gear (speed) used and the time stopped in the field. The harvesters studied were one-row, two-gear (speed) machines designed to operate at 2.00 miles per hour in first gear and 2.75 miles per hour in second.* This rate would permit covering 0.77 acre per hour in first gear and 1.06 acres in second on cotton in 38-inch rows if continuous operating in one direction were possible. Harvesters cannot maintain these rates, however, because they must stop for turning, unloading the basket, and for servicing and adjustment. The harvesters studied picked, on the average, 0.60 acre per machine-hour in first picking and 0.85 acre in second picking, considering time for the stops just mentioned.

The quantity of cotton a harvester will pick in a given time is directly related to yield and to the quantity of open cotton. The harvesters studied picked, on the average, 1,021 pounds of seed cotton per machine-hour in first picking and 429 pounds in second picking (table 11).† One machine operated successfully in cotton yielding 2.7 bales per acre; it picked 3,585 pounds of seed cotton per machine-hour in first picking.

Another measure of performance is the pick per working day. The harvesters averaged 7.0 bales per workday in first picking and 2.3 bales in second picking, or 4.9 bales over the season. The machine that operated in 2.7-bale cotton averaged 17.2 bales a day.

Discussion

Many growers made maximum use of their machines during the 1949 season. They proceeded with machine first picking, even though chemical defoliants generally were ineffective, and found

* As indicated in the 1949 Owner's Manual furnished with the harvester.

† Second picking was not necessarily on the same fields as first picking.

Table 11. Average Performance Rates of 63 Mechanical Cotton Pickers, San Joaquin Valley, 1949

Item*	San Joaquin–Valley	Area				
		Kern	Eastside	San Joaquin–Tranquillity	Westside	Madera–Merced
	pounds					
Seed cotton harvested per machine-hour:						
First picking	1,021	1,182	1,016	1,040	1,062	772
Second picking	429	521	475	322	408	584
All picking	783	903	792	856	826	560
	bales					
Bales harvested per workday:						
First picking	7.0	7.0	7.6	5.8	7.6	6.9
Second picking	2.3	2.1	2.8	1.3	2.4	2.1
All picking	4.9	4.6	5.4	4.4	5.6	4.3

* Other rates, "acres per machine-hour" and "bales per machine-hour," are found in table 13.

that results were more successful than they expected. It frequently proved possible to use machines before the plants had defoliated if leaves had wilted to a dull gray-green and if a good percentage of the bolls were open.* After midseason, under pressure of a huge harvest, some machines actually picked beyond their effective capacity by operating when conditions were unfavorable, during nights when humidity was unduly high and days when fog or dew was excessive. Consequently, growers often found that in pressing output to the limit they reduced output per hour and obtained lower lint grades.

About half the growers, for various reasons, did not make full use of their machines. Some hesitated to use machines in first picking; others, because of previous unsatisfactory experience, used machines merely to supplement hand picking. Lack of experience handicapped those using machines for the first time, and some bought machines after the picking season had begun. Nearly all growers who used machines at less than capacity in 1949 said they would use their machines more fully in the 1950 season. This intention was not fully realized because the acreage of cotton was sharply reduced in 1950; but apparently most machines operated at full capacity in 1951 when the average pick was estimated at 264 bales per machine (table 6, page 9).

A grower who is considering converting to mechanized harvesting needs to know how much a machine will pick in a normal season. The experience of 31 growers operating a full season in 1949 indicates that growers can expect to operate 60 working days or 500 hours in a typical season. It can safely be assumed that a machine can harvest completely 200 acres of cotton and pick 300 bales in a season. All the cotton, as a rule, would open before first picking was finished, so perhaps no more than 150 acres would require a second picking. If so, the total would be the equivalent of 350 acres once over. These estimates seem reasonable enough even though 1949 was somewhat more favorable than an average season for machine harvesting. It is believed that improved equipment plus greater operating skill has increased seasonal capacity per machine enough to permit such performance even in seasons of less favorable weather conditions.

EFFECT OF MACHINE PICKING ON GIN TURNOUT

Growers, ginners, and others in the cotton industry have been concerned about the effects of machine picking on gin turnout. Gin turnout is the ratio of lint to seed cotton and trash. Seed cotton usually contains moisture and varying amounts of leaves, stems, sticks, and other foreign material. Turnout is important because it is an inverse expression of the amount of foreign material termed "trash" in the cotton.† Low trash content—high turnout—is desired because the greater the amount of foreign material, the more difficult it is to gin out a high-grade sample of lint and because excess foreign matter increases the cost of ginning, as ginning charges are based on the weight of seed cotton.

Mechanical harvesters can reduce gin turnout by collecting with the seed cotton more trash than hand pickers or by adding excessive moisture from the spindle moisteners. But if technical improvements or greater operating skill can decrease the amount of foreign material gathered with the cotton, mechanical pickers may actually improve the grade.

The weight of seed cotton and lint was

* Growers reported that wilting can be induced by timely removal of irrigation water.

† Turnout may also reflect the thoroughness with which the gin removes lint from seed, but that fact is more directly determined by inspection of seed as it comes from the gin.

tabulated from the gin statements for the interviewed growers and used to compare gin turnout of machine- and hand-picked cotton according to season averages and by periods through the season.

Among the 63 interviewed growers, the season average gin turnout of machine-picked cotton (36.5 per cent) was less than one percentage point lower than that of hand-picked cotton (37.1 per cent,* table 12). On the average, it took 1,370 pounds of machine-picked seed cotton, as compared with 1,348 pounds of hand-picked, to make a 500-pound bale of lint cotton. Gin turnout of machine-picked cotton was lower, though not to the same extent, in each of the subareas except San Joaquin-Tranquillity. In that area, gin turnout of machine-picked cotton (37.2 per cent) was actually higher for the season than turnout of hand-picked cotton (35.5 per

* Gross weight of bales was used throughout in calculating gin turnout.

Table 12. Gin Turnout by Method of Harvest, San Joaquin Valley, 1949*

	Four-week periods					
	First	Second	Third	Fourth	Fifth	Season average†
	Sept. 11–Oct. 8	Oct. 9–Nov. 5	Nov. 6–Dec. 3	Dec. 4–Dec. 31	Jan. 1–Jan. 28	
	per cent					
San Joaquin Valley						
Machine picked	36.7	37.2	36.8	34.7	32.2	36.5
Hand picked	39.1	37.9	36.8	35.0	30.7	37.1
Difference‡	−2.4	−0.7	....	−0.3	+1.5	−0.6
Subareas						
Kern:						
Machine picked	32.4	36.2	35.0	31.9	30.0	34.4
Hand picked	37.8	37.4	37.1	36.4	29.0	36.8
Difference‡	−5.4	−1.2	−2.1	−4.5	+1.0	−2.4
Eastside:						
Machine picked	38.4	36.6	36.5	34.5	33.0	36.2
Hand picked	39.2	37.9	35.7	33.4	30.8	36.9
Difference‡	−0.8	−1.3	+0.8	+1.1	+ 2.2	−0.7
San Joaquin–Tranquillity:						
Machine picked	....	37.3	37.8	36.2	33.4	37.2
Hand picked	....	38.0	37.6	35.2	31.5	35.5
Difference‡	....	−0.7	+0.2	+1.0	+1.9	+1.7
Westside:						
Machine picked	37.3	37.8	37.0	35.2	31.0	36.9
Hand picked	39.3	37.9	37.1	36.6	31.1	37.6
Difference‡	−2.0	−0.1	−0.1	−1.4	−0.1	−0.7
Madera–Merced:						
Machine picked	38.4	37.3	36.4	34.5	33.3	36.5
Hand picked	39.2	38.1	37.1	35.3	27.8	37.6
Difference‡	−0.8	−0.8	−0.7	−0.8	+5.5	−1.1

* Data include all machine-picked and hand-picked cotton of 63 growers. Gin turnout is the ratio of lint to seed cotton and trash.
† Season average of all cotton picked, not a simple average of the five 4-week periods.
‡ Minus sign indicates machine below hand, plus sign, machine above hand.

cent). It may be noted that San Joaquin-Tranquillity had the highest turnout from mechanical picking and the lowest from hand picking of any area.

For the growers interviewed, gin turnout of hand-picked cotton followed the usual pattern, starting high and declining steadily throughout the season. In contrast, machine-picked turnout increased from September (36.7 per cent) to October (37.2 per cent), nearly equaled hand-picked in midseason, and was actually higher than hand-picked in late-season picking (table 12).* In short, turnout of machine-picked cotton improved relative to that of hand-picked throughout the season both for the Valley average and for each of the subareas (table 12).

Gin turnout of machine-picked cotton was remarkably good on the whole. The concern people felt when machines first came into use was apparently unjustified. Machine-picked turnout showed up less favorably early in the season, because machines collected more green leaves and other trash than hand pickers. After the cotton had defoliated, gin turnout performance of machine-picked cotton was comparable with that of hand-picked. The fact that machine-picked turnout compared favorably late in the season may be explained by very poor hand picking at that time.

MACHINE-PICKING COSTS

The term "picking cost" as used here includes overhead and operating costs for the picker and tractor plus cost of labor. It excludes field waste and grade loss, both of which are recognized as "economic costs" in comparisons of mechanical with hand harvesting but which are analyzed in later sections of this report.

Average picking cost per machine

Total machine-picking cost during the 1949 season averaged $3,355 per machine for the 63 growers interviewed. The component items included an average of $1,734 for overhead, $1,016 for operating cost, and $605 for labor. Overhead thus represented more than half the total cost for the Valley as a whole, and this same pattern with minor variations was repeated in the subareas (fig. 4 and table 34, page 55).

Overhead costs. Overhead costs include depreciation, interest on investment, property taxes, and insurance on the picker and tractor. Depreciation during the life of a machine is the original cost minus the ending or salvage value. Original cost, which obviously is vital in determining depreciation, averaged $6,459 for the harvesters and $2,950 for the tractors used to harvest cotton. Length of life, the other essential factor in calculating annual depreciation, was estimated at five years for harvesters and seven years for the tractors on which they were mounted, except that machines with very high annual use depreciated more rapidly. Total depreciation averaged $5,490 for the harvesters, and this amount divided by 5 and corrected for machines receiving greater than annual use resulted in an average annual depreciation of $1,112.

The estimate of harvester life had to be somewhat arbitrary. The oldest machines included in the survey were purchased in 1947, and it was not known how many years they would operate. Major modifications and improvements had already been made at the time of the interviews, and others were expected to follow. It was impossible, therefore, to determine from experience the average length of life. The five-year estimate actually used was considered reasonable, however, and represented the combined

* Neither snaps nor bollies were included in hand picking.

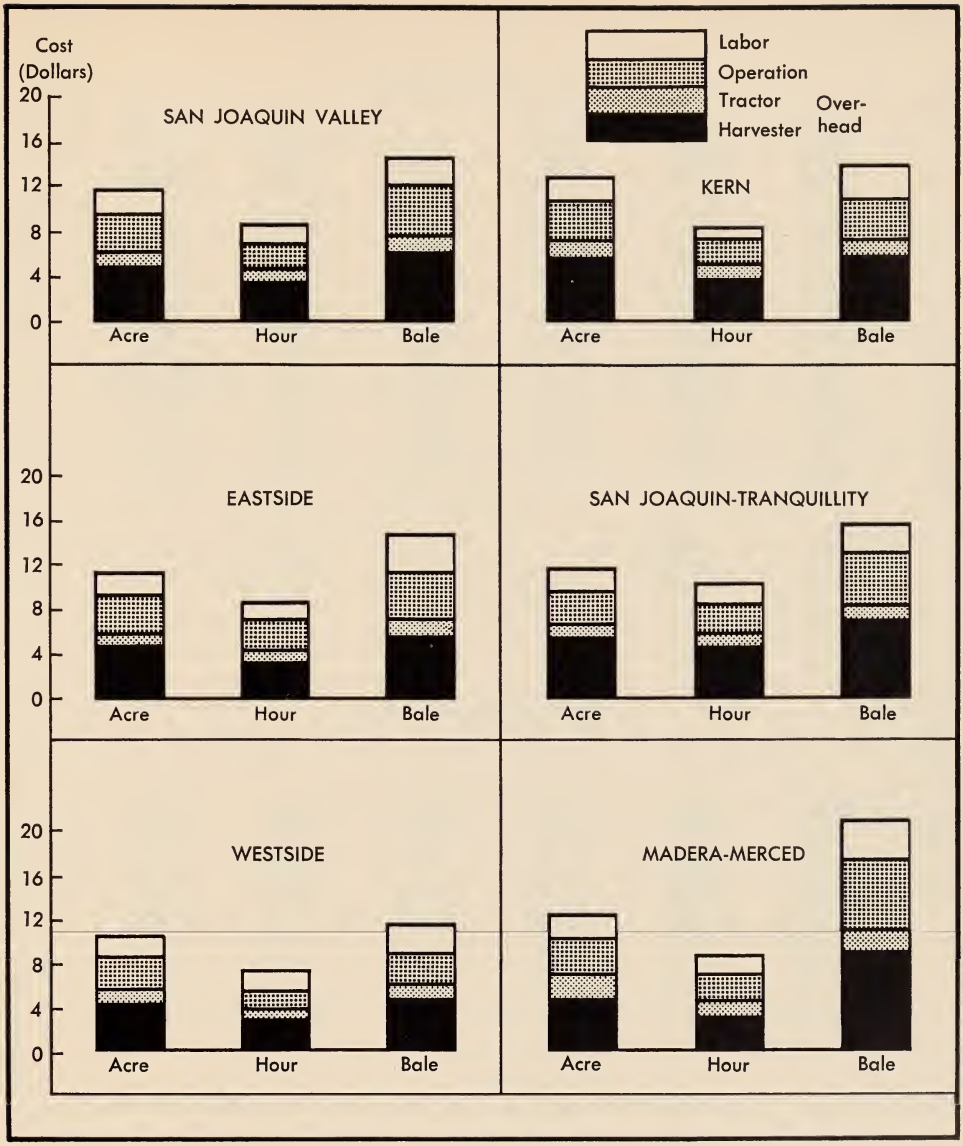


Figure 4. Mechanical cotton picking costs in the San Joaquin Valley, 1949; costs per acre, per bale, and per hour; usual overhead, operating and labor expense. (Overhead cost of picker and tractor accounted for most of the total, with picking operations and labor the other major items.) Source of data: Tables 14 and 34.

judgment of experienced machine operators and dealers.

The annual charge for interest on investment was estimated at $149 per machine, a sum much smaller than that for depreciation. Property taxes and insurance averaged $123 and $33, respectively, for each harvester.

Overhead cost for the tractor was handled differently than for the harvester in two respects: 1) annual repairs were included in overhead; and 2) only a part of the total overhead cost was charged to cotton harvesting. That was done because, typically, the tractor was used for other work at other times of the

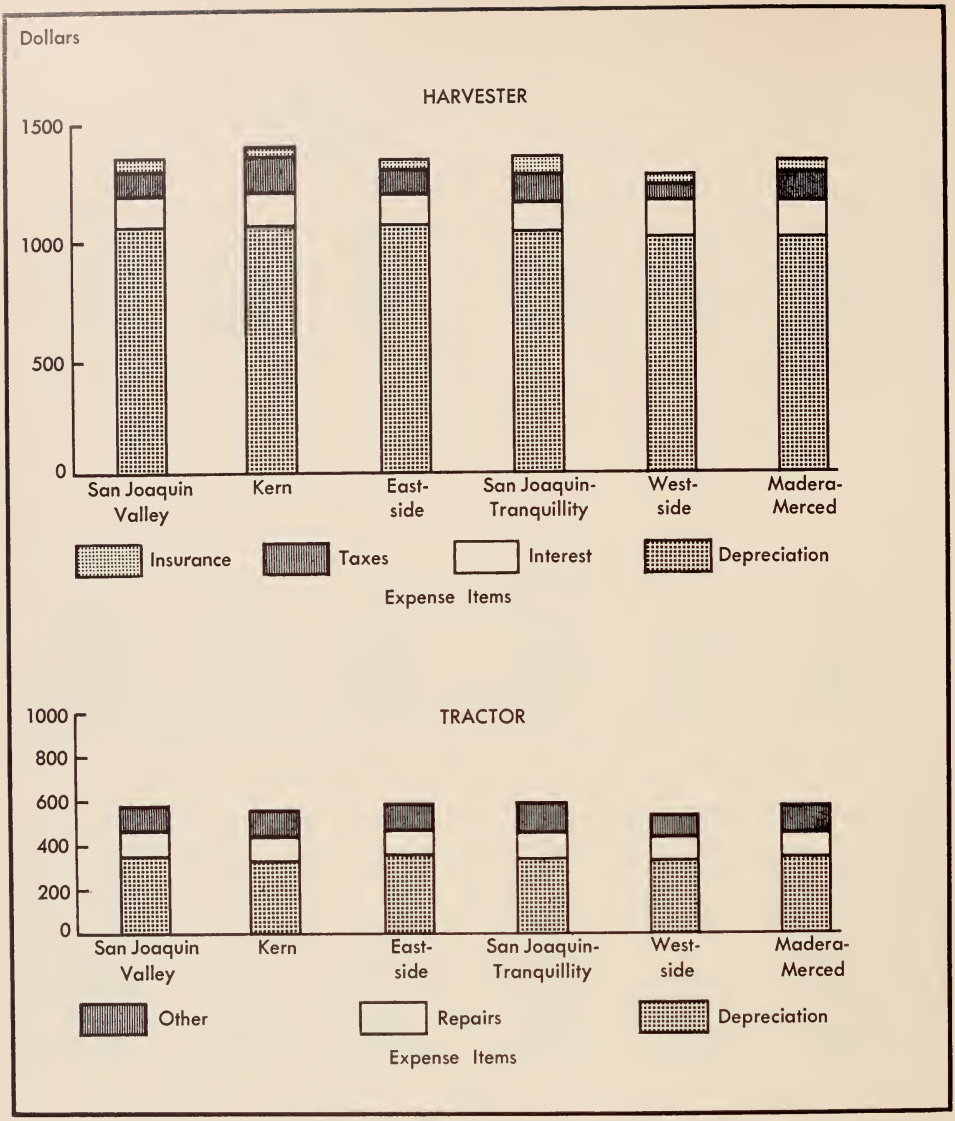


Figure 5. Overhead costs for mechanical cotton picking in the San Joaquin Valley, 1949; mechanical harvesters and tractors. (Depreciation was the main item of overhead cost, and the harvester accounted for most of the total.) Source of data: Table 35.

year. Depreciation still accounted for 63 per cent of the overhead cost, while interest on investment accounted for 12 per cent.

Variations among the subareas were minor, as might be expected in view of the newness of the mechanical harvester and the close similarity in age and mechanical condition of the machines studied.

Operating costs. Expenses on the harvester averaged $869, or more than half the annual costs (fig. 6). Labor expenses ($605) ranked second, representing about 40 per cent, and tractor operating expense ($147) accounted for slightly less than 10 per cent.*

* The tractor expense is somewhat misleading inasmuch as repairs were included with overhead as indicated above.

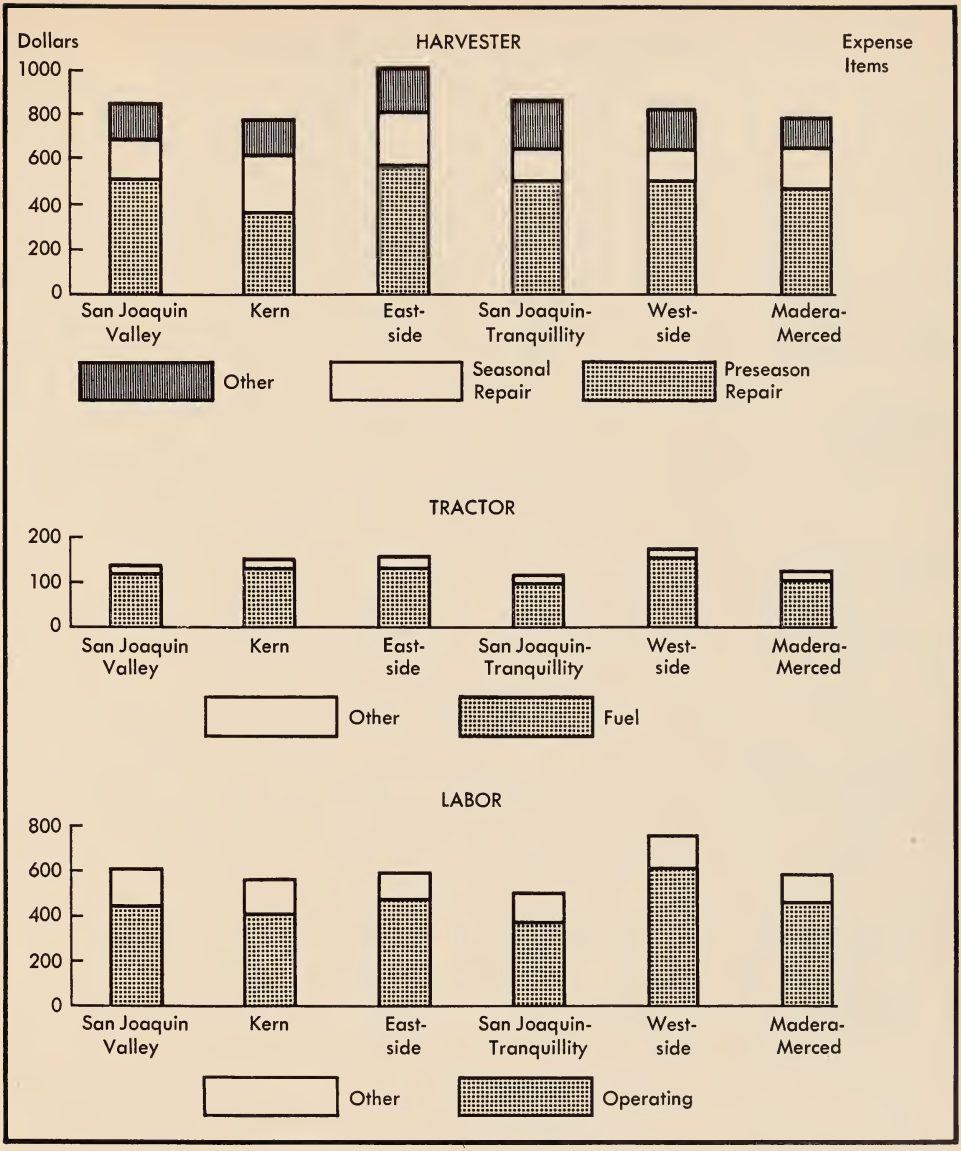


Figure 6. Operating expenses for mechanical cotton picking in the San Joaquin Valley, 1949; mechanical harvesters, tractors, and labor. (Major expense items were preseason repair on the harvester, operating labor, and tractor fuel.) Source of data: Table 36.

The largest item in harvester expense was preseasonal repair, $505 on the average, while seasonal repair required another $200. The two items of maintenance together, $705, represented 80 per cent of the operating expenses for the harvester. Preseasonal repair was difficult to estimate because a number of the machines were new in 1949. The estimate used is based on the average reported by those operators who had used machines for at least one year before 1949. Costs of mounting and dismounting the harvester unit in order to use the tractor for other purposes ranked third among the expense items for the harvester. Other items were relatively unimportant in total operating costs.

Table 13. Average Cost of Mechanical Cotton Picking, San Joaquin Valley, 1949

Item	San Joaquin Valley (63 growers)			
	Season total	Average per		
		Acre	Hour	Bale
Acres of picking	284	....	0.69	1.24
Machine-hours	407	1.43	....	1.78
Bales harvested	229	0.81	0.56	....
Investment				
Harvester	$ 3,714	$ 13.08	$ 9.12	$ 16.22
Tractor	1,696	5.97	4.17	7.41
Total	$ 5,410	$ 19.05	$ 13.29	$ 23.63
Picking Costs				
Overhead:				
Harvester	1,417	4.99	3.48	6.19
Tractor	317	1.12	0.78	1.38
Total	$ 1,734	$ 6.11	$ 4.26	$ 7.57
Operating expenses:				
Harvester	869	3.06	2.14	3.80
Tractor	147	0.52	0.36	0.64
Total	$ 1,016	$ 3.58	$ 2.50	$ 4.44
Labor:				
Operating*	506	1.78	1.24	2.21
Service and repair	84	0.30	0.21	0.37
Farm shop	8	0.03	0.02	0.03
Compensation	7	0.02	0.02	0.03
Total	$ 605	$ 2.13	$ 1.49	$ 2.64
Total picking costs	$ 3,355	$ 11.82	$ 8.25	$ 14.65
	man-hours			
Labor used				
Operating	407	1.43	1.00	1.78
Other	101	0.36	0.25	0.44
Total	508	1.79	1.25	2.22

* Includes bonuses. The following number of growers paid bonuses averaging the indicated amounts by subareas: Kern, seven growers, $208; Eastside, two growers, $188; San Joaquin–Tranquillity, two growers, $247; Westside, one grower, $460; Madera–Merced, one grower, $94.

Labor costs. Labor for operating the harvester in the field was responsible for most of the labor expense, while labor for services and repair ranked second (fig. 6). A few operators were paid wage bonuses, which were considerable items of expense for those reporting but which averaged only $46* for all growers interviewed. Because most of the repairs were made in dealers' shops, "farm labor" expense for repairing harvesters was relatively low.

Cost per bale, per hour, per acre, and per 100 pounds of seed cotton

The average cost of machine picking in the Valley was $14.65 per *bale* for the growers interviewed (fig. 4 and table 13). More than half the cost was overhead ($7.57), a third was operating expense ($4.44), and the remainder was labor ($2.64). The cost varied widely among the subareas because a machine picked more bales in some areas than in others (table 14). The average cost was lowest ($11.71 per bale) in Westside where the season's pick averaged 292 bales per machine. It was highest ($20.72 per bale) in Madera-Merced where the average pick was only 158 bales. Variations in yield per acre largely caused the variation in bales picked per machine and in costs per bale.

Costs per *acre* for picking one time over averaged $11.82 for the interviewed growers in 1949. This figure was highest in Kern ($12.62) where the smallest acreage was picked per machine and lowest in Westside ($10.80) where the largest acreage was picked. The range in cost per acre was considerably narrower than the range in costs per bale.

On an *hourly* basis, the Valley average cost of machine picking was $8.25. The high ($10.04) was in San Joaquin-Tranquillity where machines operated the fewest hours, the low ($7.15) in Westside where they were used the most. Per-hour costs also show a much narrower spread than costs per bale.

* Bonuses were more commonly paid machine operators in Kern than in other areas. Almost half of the farmers interviewed in Kern paid such a bonus, averaging $208 for the season, and these farmers represented more than half of all interviewed in the Valley who reported bonus payments.

Table 14. Cost of Mechanical Cotton Picking, by Subareas of the San Joaquin Valley, 1949

Item	Kern	Eastside	San Joaquin–Tranquillity	Westside	Madera–Merced
Acres of picking	263	309	273	317	265
Machine-hours	414	427	316	479	387
Bales picked	258	245	201	292	158
Cost of picking*					
Per acre	$ 12.62	$ 11.22	$ 11.61	$ 10.80	$ 12.35
Per hour	8.02	8.13	10.04	7.15	8.46
Per bale	12.86	14.15	15.77	11.71	20.72
Per 100 pounds of seed cotton†					
First pick	0.68	0.80	0.96	0.67	1.09
Second pick	1.54	1.71	3.13	1.75	2.60
All picks	0.89	1.03	1.17	0.86	1.51

* Costs per acre, per hour, and per bale are averages of all picking both first and second. These costs exclude field waste and grade loss reported elsewhere in this publication.
† Includes lint, cottonseed, and trash as weighed in the trailer at the gin.

The average cost of machine picking per *hundred pounds* of seed cotton was $0.81 in first picking and $1.93 in second picking. The cost was higher in second picking because less seed cotton was picked per hour. Average costs of picking in the subareas are summarized in table 14.

Materials and labor used. Spindle oil was used in volume by the mechanical pickers. Typically, an initial purchase of wetting agent was made, but after this had been used, no more was bought. Some operators reported successful use of a popular brand of detergent instead of a special wetting agent. Fuel and oil were the principal materials required for tractor operation. The 63 growers reported an average use of 809 gallons of fuel. Most of the labor was used in operating the picker in the field. On the average, 407 of the total 517 man-hours were used in field operations. Servicing and minor field repairs amounted to another 75 hours. The labor reported does not include that used to operate trailers or trucks in hauling the seed cotton to the gin. Only a few operators indicated that added labor was used to load the trailers or to tramp the cotton; such labor was not included in this report.

Discussion

The average cost of $14.65 per bale for machine harvesting compares with approximately $45.00 for hand picking.*

Two facts stand out regarding picking costs: 1) the dollar investment in the harvester and tractor makes high overhead costs inevitable in the form of depreciation and interest on investment; and 2) preseasonal and seasonal repair costs for the harvester dominate operating costs.

The first point emphasizes the importance of making full use of the mechanical cotton harvester. The impression was gained during interviews that added experience in using and servicing the harvester would help to reduce breakage and wear. Many machines were delivered in 1949 and many operators gained their first experience in that year. In some instances, the operator had no specific training before taking the machine to the field. Further experience and definite preseason training for operators would, growers believed, help to cut costs.

The quantity of cotton harvested annually greatly affects the cost per bale of machine picking. Cost per bale was high in Madera-Merced because fewer bales were harvested there than in the other subareas. One machine could harvest appreciably more cotton than usually was reported. Westside growers, for example, reported 292 bales harvested—64 bales, or 28 per cent more than the Valley average. The factors responsible in 1949 for limiting the number of bales harvested per machine have been noted. Thoughtful planning can bring about more complete use. Experience in the 1951 season, when mechanical pickers in California averaged 264 bales, demonstrates that it is feasible to pick 250 or more bales per machine per year. This fact is further substantiated by the 1949 average per machine in Westside (292 bales).

Added years of service life beyond the five or seven years assumed for picker units and tractors would tend to reduce harvesting costs by lowering the annual cost of depreciation. The cost of obsolescence should be less important now that mechanical picking is established and particularly now that manufacturers have several years of field experience in testing and improving their machines. It is likely, also, that length of service life will be extended by more effective operation and maintenance of the machines.

* The cost of hand picking was estimated by assuming 13.5 hundredweight of seed cotton for a bale of lint and multiplying by the 1949 picking cost. The latter figure averaged $3.33 for first and second hand picking according to the growers reporting.

EFFECT OF MACHINE PICKING ON GRADE OF LINT COTTON

The effect of machine picking on the quality of cotton is a matter of prime importance. If machine picking causes lower grades than hand picking, the cotton will have less value, and this reduction represents an economic cost of machine harvesting.

The over-all effect of machine picking on grades of lint cotton can be shown by comparing the grades of machine-picked and hand-picked bales of cotton grown, harvested, and ginned under similar conditions. All three requirements were met in this study because bales picked by both methods and coming from the same gins were analyzed to determine comparative grades.* Almost all cotton going through a given gin is from the immediate neighborhood where soils, weather, and other environmental conditions are similar. Also, all cotton was of the same Alcala variety. Most of the differences in grades, therefore, almost surely reflect variations in harvesting methods.†

How machine picking can affect grades of cotton

Cotton is assigned class grades according to leaf content (trash), color, and preparation of the lint. For classification, samples of lint are cut from the bale. High-grade lint has little trash, is white, and has "normal preparation." The variations in leaf (trash) content are recognized in seven grades which which range downward from Good Middling, having the least trash, to Good Ordinary, having the most. If the trash consists of grass particles, the cotton sample is further reduced one or more

* Data on cotton grades supplied by interviewed growers were inadequate for this analysis because the farms were so scattered that seldom more than one or two were served by the same gin.

† It was not practicable to collect data exclusively from fields where both machine and hand picking were done because it is uncommon for growers to use both methods in the same field at the same time of the season.

NOTE: All grades analyzed in this section and throughout the report were those assigned in the U.S.D.A. Classing Office, Bakersfield, California. The official grades and standards for American Upland Cotton in effect at the time data were collected for this study were superseded on 18 August 1953. *Federal Register;* 15 August 1952. The new official grades and standards are as follows:

White Cotton
- Good Middling
- Strict Middling
- Middling
- Strict Low Middling
- Low Middling
- Strict Good Ordinary
- Good Ordinary

Spotted Cotton
- Good Middling Spotted
- Strict Middling Spotted
- Middling Spotted
- Strict Low Middling Spotted
- Low Middling Spotted

Tinged Cotton
- Good Middling Tinged
- Strict Middling Tinged
- Middling Tinged
- Strict Low Middling Tinged
- Low Middling Tinged

Yellow Stained Cotton
- Good Middling Yellow Stained
- Strict Middling Yellow Stained
- Middling Yellow Stained

Gray Cotton
- Good Middling Gray
- Strict Middling Gray
- Middling Gray
- Strict Low Middling Gray

The new classification has no effect on the applicability of findings of this study regarding White and Extra White Cotton. These colors already are combined in this analysis, while there was no cotton in the two top grades that have been eliminated—Middling Fair and Strict Good Middling.

grades below what otherwise would be assigned. Cotton is also classed according to color as white, spotted, tinged, yellow stained, or gray. Preparation refers to the arrangement of the fibers in the sample. One showing gin-cut staple, for example, may be reduced one or more grades because of this factor alone.

Grades of lint cotton are affected by the quality of standing cotton, picking and handling methods, and the ginning. Immature or weather-stained seed cotton, with consequent discoloration from spotting, staining, or graying, will not produce good grades, however excellent the picking or ginning. Some leaf (trash) is collected along with the seed cotton in picking, whether it is done by hand or by machine. Also, discoloration, especially green leaf stain, may occur regardless of the picking method. Gins are equipped to remove much of the trash collected in picking, but they cannot remove discoloration. Gins vary in respect to cleaning equipment, although recently most gins in California have installed lint cleaners. The skill with which they are operated also varies.

Mechanical cotton pickers may reduce lint grades below those that would have been attained by hand picking in the following ways:

1. By introducing more green leaf stain in early season.
2. By introducing more trash from the dead cotton plants late in the season.
3. By gathering more foreign matter from weeds or grass.
4. By adding excess moisture (in spindle moistening) to the seed cotton, making trash removal by gin cleaners more difficult. (Whether moisture also induces graying or mildewing has not been definitely proven.)
5. By twisting or tangling lint on the spindles, thus increasing difficulty of normal gin preparation.
6. By discoloring the lint with oil or grease from the machine.

On the other hand, mechanical pickers may actually improve lint grades by passing over hard-to-pick immature bolls late in the season, by adding less trash than careless hand pickers, and by making possible more timely harvesting. The grade of the crop may actually average higher if it is picked earlier by machine than later by hand.

Comparative grades in the 1949–1950 season

Grades were analyzed at 35 San Joaquin Valley gins, each of which ginned 500 bales or more of machine-picked cotton. These gins reported a total of 63,000 machine-picked and 238,000 hand-picked bales for the 1949–1950 season (1949 crop). The data were also summarized to show geographical variations (fig. 7 and table 42, page 65).

Preliminary analysis showed that more than 90 per cent of the cotton picked by each method graded White. The percentage of off-color bales was slightly higher among the machine-picked (9.0) than among the hand-picked (7.9), but this difference was not statistically significant. The evidence is not conclusive whether machine picking results in more or less discoloration than hand picking. Subsequent analyses of grades, therefore, disregarded variation in color.

Bales of machine-picked cotton concentrated (46 per cent) in Strict Low Middling, whereas hand-picked bales were concentrated (41 per cent) in Middling (table 15). Machine-picked bales included 27.1 per cent Middling or higher and 26.9 per cent Low Middling or lower. Hand-picked bales included 22.9 per cent Strict Low Middling and only 8.3 per cent Low Middling or below. This same pattern, with minor variations, was repeated in each of the subareas except in Madera-Merced where machine-picked bales were concentrated in Low Middling or lower rather than in Strict Low Middling as in other areas.

Average grades of both machine- and hand-picked cotton can be calculated by

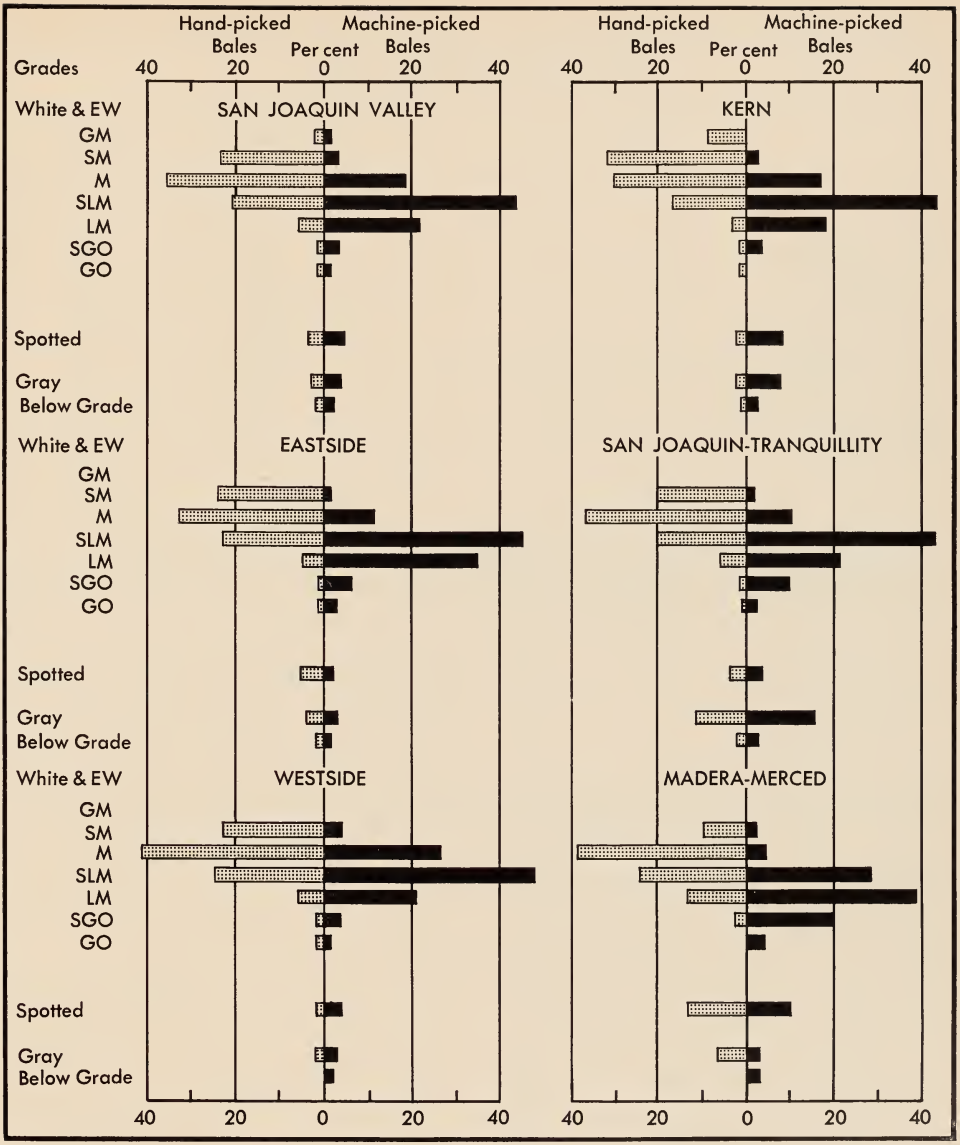


Figure 7. Grades of machine- and hand-picked cotton in the San Joaquin Valley, 1949; distribution of seasonal ginning. (Machine-picked bales tended to concentrate in Strict Low Middling White and hand-picked in Middling White grade. Machine-picked cotton averaged slightly less than one full grade below hand-picked cotton.) Source of data: Table 42.

assigning index numbers to the various grades.* Primary index numbers used in this study were:†

Good Middling	105
Strict Middling	104
Middling	100
Strict Low Middling	94

* A complete list of index numbers is found in table 45, page 70. This scale is the one used by the Production and Marketing Administration in its reports on cotton quality.

† Each index number is multiplied by the corresponding number of bales in a given lot of cotton; the totals thus obtained are summed and divided by the total number of bales to give a weighted average grade index for the lot.

Table 15. Distribution of Cotton by Grades and by Method of Harvest, San Joaquin Valley, 1949*

Grade†	Machine-picked bales	Hand-picked bales
	per cent	
Good Middling	0.1	2.5
Strict Middling	4.1	25.4
Middling	22.9	40.9
Strict Low Middling	46.0	22.9
Low Middling	21.5	6.2
Strict Good Ordinary	4.2	1.4
Good Ordinary	0.9	0.5
Below grade	0.3	0.2
Total	100.0	100.0

* Condensed from table 41, page 64, which is based on the ginnings from 35 gins in the Valley.
† Summarized by leaf or trash content only because more than 90 per cent of both machine-picked and hand-picked graded White or Extra White in color, and the small differences in color and preparation, between methods of picking, were not significant (see table 42, page 65).

Low Middling	85
Strict Good Ordinary	76
Good Ordinary	70

For the Valley as a whole, the machine-picked bales had an average grade index of 91.8, which is between Strict Low Middling and Low Middling (table 16). Hand-picked cotton had an average grade index of 97.4, which is between Middling and Strict Low Middling. The difference in grade index of 5.6 represents slightly less than one full grade.

The average value of machine- and hand-picked cotton can also be compared in terms of government loan value.* For the 35 gins in the Valley, the average loan value was $132.52 per bale of machine-picked and $142.84 per bale of hand-picked, a difference of $10.32 a bale (table 16). The difference was smallest in Westside ($8.06) and largest in the Madera-Merced area ($19.75).

Growers and others are familiar with the downward trend in grades of cotton during the harvest season. This trend is largely attributed to "weathering" and increasing trash content, both of which are particularly evident in second picking. Rain and fog contribute to coloration, and the ratio of trash to seed cotton is higher because there is less seed cotton to pick. Some growers have said that machine grades compared more favorably with, equaled, or exceeded hand grades late in the season. To make this comparison, weekly average grade indexes were obtained for each method of picking at eight selected gins for the 1949 season (fig. 8 and table 43, page 68).† Machine-picked grades on the average did not equal hand-picked at any time during the season at any of the eight gins. At five gins there was some tendency toward narrower differentials

* In estimating loan values it was assumed that all bales averaged 1 1/16-inch staple length because actual staples were not reported in these data. A very large proportion of Valley and subarea bales is 1 1/16-inch staple, so the results are not impaired by this assumption. There is no evidence whatever that machine picking has any effect on staple length.

† The data include all the machine- and hand-picked bales ginned the same two consecutive days in each week during an 18-week period. Wednesday and Thursday were used, though any other two days would have served the purpose.

as the season progressed; otherwise, machine-picked followed the same downward trend as hand-picked cotton. Grades of machine-picked varied more from week to week than the hand-picked at all eight gins. Machine grades definitely improved in the first week of November over the last week in October at seven out of eight gins after a heavy frost had defoliated the cotton and improved conditions for picking.

Individually, some growers had high grades of machine-picked cotton and others had low grades in all five subareas (table 44, page 69). That some growers in each area obtained good seasonal average grades indicates that successful machine picking is possible in all areas of the Valley. If grades are to be maintained, however, cotton must be grown with mechanical harvesting in mind. Rows must be properly spaced, the fields kept clean of weeds and grass, and the ground surface left smooth and free of clods. Recent research at the Shafter Station indicates that the crossrow ground profile is also important. If the ground is left higher in the stalk row than between the rows, the plant lifters on the machine have more space to feed low-growing branches into the machine. Too, dead leaves are more likely to fall away from the cotton stalk and are less likely to be picked up by the machine.

Trends in machine-picked cotton grades, 1948–1950

Data are available from representative gins in the San Joaquin Valley with which to compare the average grades of machine- and hand-picked cotton in each of the three years 1948–1950 (table 17; also see table 45, page 70, for a more detailed distribution of bales by grade and method of picking). Apparently the difference in grade narrowed during that period but not in the way most pleasing to growers. The smaller grade index dif-

Table 16. Average Grade Index and Government Loan Value of Cotton by Method of Harvest, 35 Gins, San Joaquin Valley, 1949

	Hand-picked	Machine-picked	Difference*
	grade index		
San Joaquin Valley	97.4	91.8	−5.6
Subareas:			
Kern	98.9	92.4	−6.5
Eastside	97.2	89.6	−7.6
San Joaquin–Tranquillity	95.4	89.1	−6.3
Westside	97.7	93.3	−4.4
Madera–Merced	94.4	85.8	−8.6
	government loan value (per bale)		
San Joaquin Valley	$ 142.84	$ 132.52	− $10.32
Subareas:			
Kern	144.79	133.94	− 10.85
Eastside	142.39	127.67	− 14.72
San Joaquin–Tranquillity	139.65	127.97	− 11.68
Westside	143.96	135.90	− 8.06
Madera–Merced	136.95	117.20	− 19.75

* Minus sign indicates machine-picked below hand-picked.

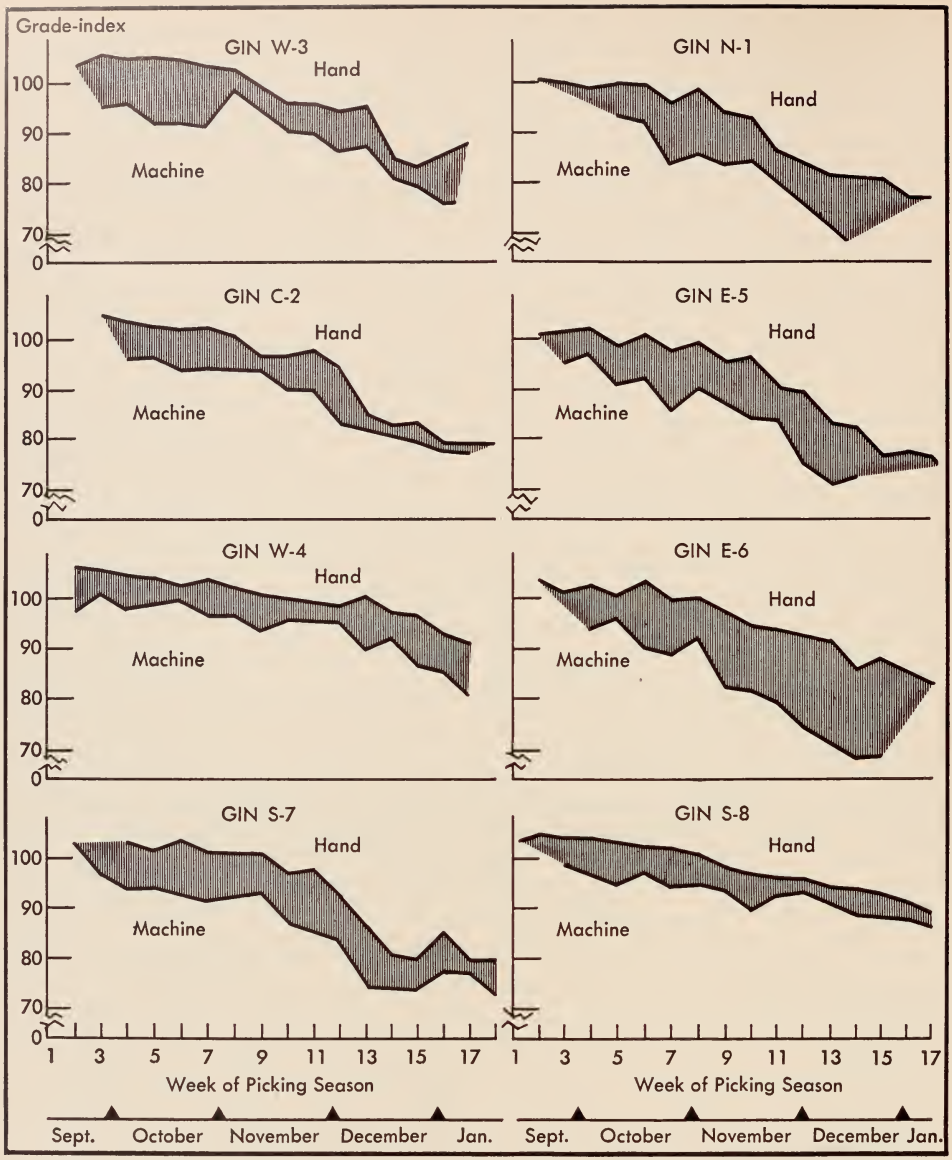


Figure 8. Seasonal trends in grades of machine-picked and hand-picked cotton in the San Joaquin Valley, 1949; weekly average grade indexes at selected gins. (Grades from the machined cotton averaged lower than hand-picked in all periods of the season. Grades for both declined throughout with some tendency for the spread to narrow.) Source of data: Table 43.

ferential of 3.1 in 1950, compared with 7.4 in 1948, resulted from a reduction in hand grades and not from any average improvement in machine grades. In fact, the latter varied only one-half point during the three years—91.3 in 1948, 91.8 in 1949, and 91.5 in 1950. Meanwhile, the hand-picked declined from 98.7 to 94.6. This decline is attributed by most informed observers to progressively poorer hand picking owing to a larger proportion of inexperienced workers. (A similar decline has been noticed in some other cotton states.) The

Table 17. Grade Index and Loan Value of Cotton from Selected Gins, by Method of Harvest, San Joaquin Valley, 1948–1950

Item	1948	1949	1950
Number of gins	22	35	26
	thousands		
Number of bales:			
Hand-picked	160	238	199
Machine-picked	17	63	63
	grade index*		
Hand-picked	98.7	97.4	94.6
Machine-picked	91.3	91.8	91.5
Difference	−7.4†	−5.6	−3.1
	government loan value (per bale)‡		
Hand-picked	$ 152.58	$ 142.84	$ 137.89
Machine-picked	142.83	132.52	131.05
Difference	− $9.75	− $10.32	− $6.84
Difference if basic loan rate were 30 cents	− $9.25	− $ 9.99	− $6.83

* See table 43, page 68, for the indexes assigned to the individual grades of cotton from which average indexes were computed.
† Minus sign indicates machine-picked below hand-picked.
‡ Loan value per pound of Middling White, 1 1/16-inch staple, by crop years was: 1948—31.62 cents; 1949—30.98 cents; and 1950—30.03 cents.

average loan value of machine-picked cotton was $6.84 per bale less than that of hand-picked cotton in 1950, compared with $10.32 less in 1949, and $9.75 less in 1948.

It is perhaps safe to say that machine picking tended to improve from 1948–1950, even though Valley-wide averages do not show it. Some growers obtained much better grades at the end of this period than when they first started to use a machine. But the Valley average was held down, and continued to be through 1952, because of the fact that many new growers, inexperienced in mechanical harvesting, were using machines for the first time and because many of these mechanical harvesting machines were used under less favorable conditions.

PICKING EFFICIENCY OF MECHANICAL HARVESTERS

To determine the net economic advantage of machine harvesting over hand picking, comparative field waste must be evaluated as well as picking costs and comparative lint grades, discussed earlier. If field waste is greater in machine than in hand picking, the field value of the additional seed cotton left by the machine also contributes to the total cost of mechanical harvesting.

Field waste means open seed cotton left in the field. Thus, field waste, or, conversely, picking efficiency, is expressed as a percentage of the total seed cotton available for picking *at the time of harvesting*. Actually there are two criteria for comparing the efficiency of machine harvesting. One is an absolute criterion, the answer to the question, "What percentage of *all* the open seed cotton does the machine pick?" The other is relative, the answer to the question, "How does the percentage of open seed cotton left by the machine compare with that left by hand pickers?" Growers are interested in the answers to both. They want their machines to be as efficient as possible, but, in terms of economic advantage, they must compare machine with hand picking, the only feasible alternative harvesting method.

A mechanical harvester can contribute to field waste in numerous ways. Like any other mechanical device, it is limited to a strictly repetitive pattern. It cannot see and therefore does not go back and pick a stray boll, once missed. The machine cannot pick cleanly if it is permitted to wander off the row. It sometimes misses the lower bolls—those six inches or less from the ground; this is more noticeable when the picker drums cannot be operated close to the ground because of roughness or clods. Another characteristic of machine-picked fields is the presence of "tag"—locks or parts of locks streaming from branches of the cotton plants. Again, if the machine becomes clogged, some cotton is soiled and must be discarded in the cleaning. In all these ways machine picking can lead to excessive field waste.

Field waste is measured accurately in only one way—by hand gleaning behind the harvester, a time-consuming job, which, if it is to provide adequate data, must include a representative range of field conditions. This was beyond the scope of the present study. Very few of the growers interviewed had actually measured field waste. Consequently, this section of the analysis is based on picking-efficiency studies made at the United States Cotton Field Station at Shafter (Hoover, 1949). Measurements of field waste at the Station were carefully taken under controlled conditions and represent the most reliable data available.

Over-all efficiency of machine harvesting was 96.5 per cent at the Shafter Station in the 1949 season. This means that at the end of the season, after second picking had been completed, the harvester had left in the field 3.5 per cent of the seed cotton available for picking. Efficiency was higher in 1949 than in previous seasons: 93.4 per cent in 1948 and 92.4 per cent in 1947.

The Shafter experiments included no hand picking in 1949 or 1947, but the mechanization project in 1948 measured the efficiency of hand picking at 97.6 per cent. This figure appears to be about the maximum efficiency to be expected in hand picking.

These efficiencies in machine and hand picking at the Shafter Station are probably somewhat higher than those attained by the average grower. However, it is believed that they represent the approximate relationship between machine- and hand-picking efficiencies that growers have experienced. These efficiencies can serve to indicate the economic im-

portance of field loss. For the purpose of this analysis, however, it is assumed that the mechanical harvester is responsible for 3 per cent more field loss than hand picking.

The average yield among interviewed growers (1949) was 2,171 pounds of seed cotton harvested per acre. If machine harvesting was 94.6 per cent efficient, the *natural* yield (amount available for picking) was 2,295 pounds per acre. Thus, machines left in the field 124 pounds of seed cotton per acre. In comparable cotton it is estimated that hand pickers picked 2,240 pounds of seed cotton and left in the field 55 pounds per acre. Thus, machines left about 69 pounds more per acre than hand pickers. The value of seed cotton in the field before picking was about $7.28 per 100 pounds in 1949.* The value of 69 pounds was, therefore, about $5.02, and the average value of field loss per harvested bale was about $3.31.

Discussion

Although few growers had systematically measured the picking efficiency of their machine harvesters, most growers said that machines did a more thorough job of "cleaning the field" in 1949 than in previous years. Very few were still concerned about field waste by the end of the 1949 season. This absence of concern may be partly because field waste actually was not large, partly because growers had learned that machine-picked fields appear to have more waste than they do, partly because they had found that machines gather in second picking some of the waste from the first, and, finally, because they were more fully aware of the extent of waste from ordinary or poor hand picking.

In general, growers expressed the opinion that field waste is relatively lower in rank-growing, high-yielding cotton. In such cotton a smaller percentage of the bolls are close to the ground where they are hard to reach. Another general conclusion is that competent machine operators are essential to efficient picking. Some growers limited the hours per work shift to avoid overfatigue and lowered efficiency of machine operators. In actual operation, the two cautions most frequently cited by growers as essential to high picking efficiency were: 1) keeping the machine on the row; and 2) keeping the machine clean.

Research at the Shafter Station indicates that row spacing of 40 inches, with cotton stalks 4 to 8 inches apart in the row, provides optimum conditions for mechanical harvesting. Other recommendations (Hoover, 1949) are that:

The rows should be uniform in height, width, and shape.

The rows should be smooth and free of clods.

The crest should be at the base of the stalk.

Furrows should be wide enough to permit steering of the picker.

* Field value of seed cotton equals the value of 37.1 pounds of lint ($9.83), plus 58.9 pounds of cotton seed ($1.40), minus (hand) harvesting costs ($3.25) and ginning costs ($0.70).

The analysis in preceding sections has been concerned primarily with the data and evidence as found. It is now appropriate to see what economic generalizations may be distilled from those data interpretations. There are important questions that cotton producers need answered. What is the total economic cost of mechanical harvesting? How do variations in annual use and in cotton yields affect picking cost? Under what situations is mechanical picking feasible? What are the comparative costs of first and second picking? Is mechanical picking economically feasible in very light picking or in scrapping operations?

Summary of economic costs

Detailed data on machine-picking costs were presented in an earlier section of this report, and it was noted that the cost of picking alone does not represent the full "economic cost" of mechanical harvest as compared with hand harvesting. Such a comparison must also consider relative lint grades and field waste of the two methods. There is evidence that machine picking results in lower grades of cotton and causes somewhat more field waste than hand picking. It is appropriate, therefore, to evaluate and summarize all the economic costs of mechanical harvesting. The analysis is based on 1949 data and prices.*

The average cost of machine picking for all growers interviewed in 1949 was $14.65 per bale. That cost was based on a total season pick of 229 bales (somewhat less than machine capacity) in the San Joaquin Valley,† and a service life of five years for the harvester. Further study revealed that for the present analysis it would be more reasonable to assume that a machine picks 300 bales per season and has a service life of six years. The picking cost adjusted for these assumptions is $12.29 per bale. Although the 1949 data showed differences in picking cost among the subareas due to variation in the season's pick, this analysis assumes the same pick and the same picking cost per bale in all subareas.

One measure of grade loss is the government loan value.‡ The loan value of machine-picked cotton averaged $10.32 per bale lower than hand-picked cotton in 1949. Because the loan-value differential varied among the subareas of the Valley, it seems reasonable to assign different charges for grade loss in each. It is recognized that the differences found in 1949 may become smaller as the newer areas gain experience in machine picking. Some differences, nevertheless, are expected to persist because of cropping and cultural variations in the subareas.

Machine picking in 1949 resulted in 3 per cent more field waste than hand picking (see pages 36–37). In 1.5-bale cotton machine picking left 65 more pounds per acre of seed cotton in the field than hand picking. The economic cost thus represented amounted to $4.73 per acre, or $3.15 per harvested bale.§ No significant variations in field waste among the subareas were noted.

The total economic cost of machine harvesting averages $25.76 per bale in the San Joaquin Valley, under the conditions assumed. The cost is highest ($35.19) in Madera-Merced where grade loss averages highest; it is lowest

* Although prices, and therefore costs of picking, were relatively higher in 1950 and 1951, the 1949 price level is deemed more representative of the long-time future average.

† The average pick in 1951 was estimated at 264 bales per machine.

‡ Much of the 1950 and 1951 crops sold at prices well above loan value, but volume of sales of particular grades by specific margins is not known.

§ The computation of the field value of $7.28 per 100 pounds of seed cotton was shown in the footnote on page 37.

($23.50) in Westside where grade loss is lowest. The net economic advantage of machine picking over hand picking is $19.24 a bale in the Valley; it is highest in Westside and lowest in Madera-Merced (table 18).

If grade loss continues to diminish, as the 1948–1949 trends suggest, the total economic cost of machine picking will become lower. The net economic advantage of machine picking, therefore, will tend to increase.

Some might argue that *no* grade loss should be charged to mechanical harvesting. Machines picked some 15 per cent of the 1949 crop, hence the harvest was completed earlier than if it had been picked entirely by hand. Even with the help of machines, about 15 per cent of the crop was not picked until after December 13.* Without machines, even more of the crop (perhaps 15 per cent more) would have been harvested after mid-December when the standing cotton and the ginned lint are of lower grades.

* Computed from Cotton Quality Reports, Production and Marketing Administration, Bakersfield, California.

† It is assumed the 900 machines each picked 229 bales, the average found among interviewed growers.

California cotton ginned between mid-December and mid-January averaged Low Middling (grade index of 85.7). The average grade index for machine-picked bales for the entire season was 91.8, about three-fourths of a grade above Low Middling. The difference in loan value between a Strict Low Middling and a Low Middling bale was about $25.00. It might, therefore, be reasonable to assume that approximately 205,000 bales of cotton† were $18.75 a bale higher in value, though machine picked, than they would have been hand picked, *at a later date*. That is to say, a machine-picked bale in October was worth more than a hand-picked bale in December. The individual grower who uses or contemplates using a machine, however, *must* consider grade loss as a cost of machine harvesting. Operators, on the average, received lower grades when they used machines. Individually, they could have used hand pickers and obtained higher grades, even though not all of them could have obtained enough hand pickers. In a sense, growers who used machines (and took lower grades) made it possible for other growers to complete their harvest with hand pickers (and get

Table 18. Total Costs of Machine Picking Compared with Hand Picking

Item	Hand picking	Machine picking					
		San Joaquin Valley	Subareas				
			Kern	Eastside	San Joaquin–Tranquillity	Westside	Madera–Merced
Picking cost	$ 45.00	$ 12.29	$ 12.29	$ 12.29	$ 12.29	$ 12.29	$ 12.29
Field waste	.....	3.15	3.15	3.15	3.15	3.15	3.15
Grade loss	.....	10.32	10.85	14.72	11.68	8.06	19.75
Total economic cost*	$ 45.00	$ 25.76	$ 26.29	$ 30.16	$ 27.12	$ 23.50	$ 35.19
Difference in favor of machine picking	.....	$ 19.24	$ 18.71	$ 14.84	$ 17.88	$ 21.50	$ 9.81

* Additional ginning costs for machine-picked cotton, averaging about 11 cents per bale, not included.

higher grades). In this sense, grade loss seems a real and direct loss to growers who use machines.

Effect of changing prices on machine- vs. hand-harvesting costs

Some farmers may question whether the cost of machine harvesting would equal or exceed the cost of hand harvesting if picking wage rates again become relatively low as in times past. This question is important to a farmer considering a shift from hand to machine picking. The answer turns on the probability of lower wages relative to prices and costs of operating farm machinery. As a partial answer, we can first examine those periods in the past when price relationships (cheap labor) were unfavorable to mechanization. We can then speculate about the future.

Between 1935 and 1952, the year 1938 was the one in which farm wage rates were lowest relative to prices and costs of operating farm power machinery. In 1938 the index of wage rates for picking cotton was only two-thirds as high as the index for machinery prices (table 19). That means that labor was relatively cheap. On the other hand, in 1949 the index of wages was 1½ times the index of machinery prices. This study has shown the cost of machine picking for that year as $2.05 per 100 pounds of

Table 19. Indexes of Prices Paid by Farmers in the United States and Wage Rates for Picking Cotton in California (1910–1914 = 100)

Year	Farm machinery	Farm supplies	Farm wage rates	Wage rate for picking 100 pounds of seed cotton*	
	index				index
1934	144	134	99	$0.90	123
1935	148	134	107	0.90	123
1936	150	136	114	1.00	136
1937	153	143	129	0.95	130
1938	158	146	130	0.75	102
1939	155	142	127	0.85	116
1940	153	146	129	0.95	130
1941	155	156	151	1.30	177
1942	164	172	197	1.90	259
1943	170	192	262	2.10	286
1944	174	201	318	2.25	307
1945	176	204	359	2.25	307
1946	182	206	387	2.90	396
1947	206	222	419	3.00	409
1948	240	236	442	3.00	409
1949	270	246	430	3.00	409
1950	275	247	432	3.45	470
1951	297	264	481	3.70	505
1952	308	280	...†	3.60	491

Source: Bureau of Agricultural Economics.

* Average rate paid up to November 1; includes rates paid for snapping bolls converted to seed-cotton equivalent. As picking wage rates were not reported before 1934, the index was converted to the 1910-1914 base by assuming that the relationship between picking rates and all United States farm wage rates was the same in 1910–1914 as in 1935–1939.

† Data not available.

seed cotton, compared with $3.25 for hand picking. Since World War II labor generally has been scarce and wage rates high, a situation that encourages mechanization.

When 1949 machine-harvesting costs, as determined in this study, are converted to 1938 prices, the resulting cost of picking 100 pounds of seed cotton is:

Machine-picking cost	$0.465
Value of grade loss	.213
Value of field waste	.065
Total	$0.743

These estimates are for a machine with full season use on 200 acres of cotton and 300 bales picked. This cost would be correspondingly higher if the machine picked less than 200 acres or 300 bales of cotton a season. The effect of season use on harvesting costs is discussed more fully on pages 42–45.

The estimated cost of hand harvesting per 100 pounds of seed cotton, at 1938 prices, would be:

Wages of pickers	$0.75
Supervisory labor	.08
Total	$0.83

The above comparison shows that machine harvesting of cotton would be more economical than hand harvesting even at 1938 prices, a year when wage rates were very low relative to machinery prices and costs of operation.

Another question is, "How representative is the relationship between machine-harvesting and hand-harvesting costs as found in 1949?" Is that relationship likely to change in the future, and if so, by how much? The answer to this question might be important to the individual farmer who has less than a full season's use for a mechanical picker or whose cotton yields are below average (the above costs were estimated for a yield of 1.5 bales an acre).

For this analysis, two alternative price levels were assumed. One assumes high employment and prosperous conditions. The other assumes intermediate employment and less prosperous conditions. The indexes of prices received and prices paid (1910–1914=100) for each of these projected levels compared with 1949 are shown in table 20. Table 21 shows the estimated cost of picking 100 pounds of seed cotton (including a charge for grade loss and field waste in the case of machine picking) when these price

Table 20. Index of Prices Received and Prices Paid (1910–1914 = 100)

	1949	Projected	
		High employment	Intermediate employment
Prices received:			
All products	249	215	150
Cotton, lint	245	185	126
Prices paid:			
Items in production	250	215	155
Farm machinery	270	225	175
Farm supplies	246	210	175
Wage rates	428	360	275

Source: Bureau of Agricultural Economics.

Table 21. Estimated Cost of Picking 100 Pounds of Seed Cotton When 1949 Machine- and Hand-Harvesting Costs are Converted to Projected Index Levels

	1949	Projections	
		High employment	Intermediate employment
Machine harvest cost per 100 lbs.			
Full use (200 acres):			
1.5-bale yield	$1.86	$1.48	$1.08
.75-bale yield	2.75	2.22	1.66
Half use (100 acres):			
1.5-bale yield	2.05	1.64	1.20
.75-bale yield	3.13	2.54	1.91
Hand harvest cost per 100 lbs.	3.25	2.73	1.70

Source: Bureau of Agricultural Economics.

levels and price relationships are used to convert the cost of machine harvesting and hand harvesting found in the present study.

These projections indicate that farmers who obtain cotton yields as low as 0.75 bale per acre and who harvest only 100 acres a season would find machine-picking cost only slightly lower than hand-picking under the high employment projection; under the intermediate projection, machine harvesting would cost more than hand harvesting. Farmers who usually obtain average or above-average cotton yields, even though they harvest but 100 acres of cotton a season, can expect considerably lower cost of harvesting with a machine than with hand picking. This was true in 1949 and would be true under either the high or intermediate employment conditions. It should be noted that these estimates are based on cost data in 1949 when machine harvesting, though well established, was still relatively new. Improvements in machine pickers, gins, and methods may have reduced machine-picking costs still further. An offsetting factor, of course, has been the increased prices and overhead costs of this equipment.

The cost advantage of machine over hand picking, then, may have been somewhat greater under 1949 price and wage conditions than it is likely to be under the prospective longer-term conditions. Nevertheless, the advantage is likely to be real and substantial, except for the farmer who obtains low yields of cotton and who makes only half-time or less than half-time use of a machine picker.

Effect of acreage harvested on picking costs

The machine-picking costs already presented assume a reasonably full seasonal use of the harvester—picking 200 acres of cotton, of which 150 acres is picked a second time. Some growers have more than 200 acres, while others have much less. This fact raises practical economic questions. What effect does the acreage harvested per season have on picking costs? Does it pay to maximize harvester use? What minimum acreage is needed to justify owning a harvester?

The effect of annual use upon picking cost depends largely upon the treatment given overhead. Depreciation is the major item of overhead cost, accounting for 80 per cent of the total. In turn, depreciation is related to the service life of the harvester. Service life may be the num-

Table 22. Estimated Service Life and Depreciation of a Mechanical Harvester by Acres and Hours of Annual Use

Annual use		Service life*		Salvage value‡	Depreciation cost				
Acres	Operating hours†	Years	Operating hours†		Total§	Annual‖	Per hour	Per acre	Per bale¶
25	62	8	500	$ 2,000	$ 5,000	$ 625	$ 10.00	$ 25.00	$ 16.66
50	125	8	1,000	1,500	5,500	688	5.50	13.75	9.17
75	188	8	1,500	1,300	5,700	712	3.80	9.50	6.33
100	250	8	2,000	1,000	6,000	750	3.00	7.50	5.00
125	312	8	2,500	900	6,100	762	2.44	6.10	4.07
150	375	7	2,625	900	6,100	871	2.32	5.80	3.87
175	438	6	2,625	900	6,100	1,017	2.32	5.80	3.87
200	500	6	3,000	700	6,300	1,050	2.10	5.25	3.50
225	562	5**	3,000	.....	.....	.....	2.10	5.25	3.50
250	625	5**	3,000	.....	.....	.....	2.10	5.25	3.50
275	688	4**	3,000	.....	.....	.....	2.10	5.25	3.50
300	750	4**	3,000	.....	.....	.....	2.10	5.25	3.50

* Assumed to be 8 years or 3,000 hours of use, whichever is reached first.
† Total acreage picked once and three-fourths a second time.
‡ Based on estimated "trade-in" values at end of service life.
§ Purchase price of $7,000 minus salvage value.
‖ Total depreciation divided by years of service life.
¶ Assumes an average yield of 1.5 bales per acre.
** Approximate number of years to accomplish 3,000 hours of operation.

ber of years before a machine becomes obsolete, or it may be the number of operating hours required to wear it out. In the present analysis, maximum service life is assumed to be eight years, or 3,000 hours of operation, whichever occurs first. For machines with little annual use, depreciation is considered a fixed *annual charge* to be allocated to the number of acres or bales actually harvested. For machines harvesting 200 acres or more a season, however, depreciation is treated as a fixed *charge per acre* harvested. The results of this approach are shown in an analysis of harvester use ranging from 25 to 300 acres per year (table 22).

Total depreciation during service life is calculated as purchase cost minus salvage or ending value (or trade-in value on a replacement machine). It was assumed, in the present analysis, that a machine with very little annual usage would have a higher salvage value than one with much use. A machine harvesting only 50 acres a season would have a total depreciation of $5,500 and an annual depreciation of $688, or $13.75 per acre (table 22). One harvesting 150 acres a season would have a total depreciation of $6,100, or $5.80 per acre. At 200 acres a season, depreciation becomes a uniform charge of $5.25 an acre, or $3.50 a bale. Other overhead items, such as interest on investment, general property taxes, and insurance, obviously are annual charges, whatever the acreage harvested.

The combined effects of depreciation and other overhead costs upon total cost of picking were also calculated (table 23). When a harvester picks only 50 acres per season, the average picking cost is $32.33 per acre, or $21.55 per bale. At 200 acres the cost is $18.43 per acre, or $12.29 per bale. If 300 acres are picked, the cost is $17.86 an acre, or $11.91 a bale.

When acreage harvested per season falls below 100 acres, or 150 bales at the assumed yield, the cost of picking per acre or per bale rises sharply. In contrast, when acreage exceeds 200 acres, the cost per acre falls very little. Thus, it pays a grower to make reasonably full

Table 23. Relation of Depreciation, Overhead, and Total Picking Cost to Acres Harvested Annually

Acres harvested annually†	Fixed cost per acre			Cost of using harvester per acre¶	Total picking cost*	
	Depreciation‡	Other fixed costs§	Total overhead‖		Per acre**	Per bale††
	1	2	3	4	5	6
50	$ 13.75	$ 7.15	$ 20.90	$ 25.75	$ 32.33	$ 21.55
100	7.50	3.48	10.98	15.83	22.41	14.94
150	5.80	2.33	8.13	12.98	19.56	13.04
200	5.25	1.75	7.00	11.85	18.43	12.29
250	5.25	1.45	6.70	11.55	18.13	12.09
300	5.25	1.18	6.43	11.28	17.86	11.91

* Picking cost does not include value of grade loss and field waste considered elsewhere in this report.
† Acreage shown is picked once and three-fourths a second time.
‡ See table 22 for method of calculation.
§ Based on annual sum of interest on investment, general property taxes, insurance, and cost of mounting and dismounting the picking unit divided by the number of acres harvested per season.
‖ Sum of columns 1 and 2.
¶ Column 3 plus cost of repairs, spindle oil, grease, and wetting agent, a total of $4.85 per acre.
** Column 4 plus cost of tractor use $2.85 and labor $3.73 per acre.
†† Assumes a yield of 1.5 bales per acre.

use of his harvester, but there is scant economic advantage in pressing usage to the maximum possible.

What acreage is needed to justify owning a harvester? This question is not easily answered. The data just presented would indicate that 100 acres of cotton per season can be machine harvested at a reasonable cost per bale. There are problems in financing, however, as growers are required to pay fully for machine harvesters in two harvest seasons. That means an outlay in each of these years of $3,500 for the picking unit and $1,475 for the tractor on which it is mounted (1949 prices). The savings over cost of hand picking during the first two seasons will not cover those outlays if only 100 acres are picked annually. Growers in that situation, therefore, should consider doing custom harvesting, at least until the equipment is paid for. Allotments, however, will reduce the demand for custom harvesting that existed from 1951 to 1953, seasons of unrestricted acreages.

Effect of yield per acre on picking cost per bale

Just as annual use of a harvester was found to affect the cost of picking per bale, so does the yield. To illustrate this relationship, costs of picking were estimated for various yields of cotton (table 24). It was assumed the cotton is gathered in two picks, that is, three-fourths of the acreage is picked a second time. It was also assumed the harvester is used a full season, or 500 hours of operation. The cost of picking is estimated at $7.37 per hour of operation, as derived previously.

The cost of picking an acre actually increases with greater yield because more time is generally required. The machine is cleaned and the basket emptied more often. But the cost of picking per acre does not increase proportionately to the yield, hence the cost of picking per bale decreases. These relationships are shown in table 24. In cotton yielding three-fourths bale an acre, the cost of picking

Table 24. Relation of Machine-Picking Cost Per Bale to Yield of Cotton Per Acre

Average yield per acre in bales†	Cost of picking*		
	Per acre‡	Per bale§	Per hundredweight of seed cotton‖
0.75	$15.11	$20.15	$1.46
1.00	16.07	16.07	1.16
1.25	16.95	13.56	0.98
1.50	18.35	12.29	0.89
1.75	19.82	11.32	0.82
2.00	21.67	10.84	0.78
2.25	23.14	10.28	0.74
2.50	24.47	9.79	0.71
2.75	25.06	9.11	0.66
3.00	25.65	8.55	0.62

* The basic cost is $7.37 per hour when harvester is used a full season or 500 hours of operation. Does not include value of grade loss and field waste considered elsewhere in this publication.
† Season total, of which, on the average, 80 per cent is gathered in first picking and the other in a second picking on three-fourths of the acreage.
‡ Total cost of both first and second picking.
§ Average cost of both picks, a bale of 500 pounds gross weight.
‖ Average cost of both picks; assumes 1,380 pounds of seed cotton on the average are required to make a 500-pound gross weight bale.

Table 25. Effect of Acreage and Yield Combined on Picking Costs*

Acreage harvested annually	Picking cost per bale†		
	1-bale yield	1.5-bale yield	2-bale yield
100	$ 20.96	$ 14.95	$ 12.22
200	16.96	12.29	10.68
300	15.71	11.91	10.39

* First picking on all the acreage and a second picking on three-fourths.
† The number of bales picked per season can readily be determined for each situation by the reader.

is estimated at $20.15 per bale, while in two-bale cotton it would be $10.84.

Interrelationship of acreage harvested, yield, and picking cost

There are now two economic questions to be answered: What are the combined effects of a small acreage and a high yield on the cost of picking? What happens when the acreage is large but the yield is low?

This joint effect of acreage and yield on costs is shown in table 25. It is apparent that if the acreage picked by a machine per season is small (for example, half of a full season's work) but the yield is high, the cost of picking per bale may still be reasonable. If the yield per acre is low, however, the picking cost per bale is high even though a large acreage is harvested. This analysis indicates that yield per acre has more effect than does acreage picked on picking cost per bale within the range considered.

Comparison of cost in first and second picking

The foregoing analysis raises the question of variation in picking cost between the first and second picks. The cost of machine picking per hour is about the same regardless of yield. Second picking is accomplished somewhat faster, however, and the cost per acre is, therefore, somewhat lower than in first picking. The harvester is typically operated in low (first) gear in first picking, whereas in second picking it is normally operated in high (second) gear.

For the growers interviewed in 1949, first picking required an average of 1.62 hours of operation to pick an acre; the average for second picking was 1.18 hours. Available data indicate that the cost per hour of operation is essentially the same in both picks and that the average is $7.37.* For 1.5-bale yield, about

* Second picking requires less wetting agent but apparently requires slightly more tractor fuel per hour than first picking. The two are thought to offset each other.

Table 26. Average Picking Costs in First and Second Pick

Item	Operating hours per acre	Cost per acre	Bales picked per acre	Cost per bale	Cost of seed cotton per hundredwt.
First pick	1.615	$ 11.90	1.2	$ 9.91	$ 0.74
Second pick	1.180	8.70	0.4	21.75	1.45
Both picks	2.500	18.43	1.5	12.29	0.89

Table 27. Effect of Yield on Cost of Picking Cotton, First and Second Pick

Pick (Bales picked per acre)*	Hours required to pick an acre†	Cost of picking‡		
		per Acre	per Bale*	per 100 lbs. of seed cotton§
First picking:				
2.0	2.44	$ 17.98	$ 8.99	$ 0.67
1.9	2.38	17.54	9.23	0.68
1.8	2.27	16.73	9.29	0.69
1.7	2.17	15.99	9.40	0.70
1.6	2.08	15.33	9.58	0.71
1.5	1.96	14.44	9.63	0.71
1.4	1.85	13.63	9.74	0.72
1.3	1.75	12.90	9.92	0.73
1.2	1.67	12.31	10.26	0.76
1.1	1.59	11.72	10.65	0.79
1.0	1.49	10.98	10.98	0.81
0.9	1.43	10.54	11.71	0.87
0.8	1.37	10.10	12.62	0.93
Second picking:				
0.7	1.26	9.29	13.67	0.88
0.6	1.22	8.99	14.98	1.00
0.5	1.18	8.70	17.40	1.16
0.4	1.14	8.40	21.00	1.40
0.3	1.10	8.11	27.03	1.80
0.2	1.08	7.81	39.05	2.60
0.1	1.06	7.74	77.40	5.16

* Bale of 500 pounds gross weight.
† Adapted from survey data; see table 13. Machines were usually operated in low gear in first picking and in second gear in second picking. In general, stops for cleaning the machine and emptying the basket were more frequent in higher yields.
‡ It is assumed the harvester is used a full season or 500 hours of operation. The cost of $7.37 per hour of operation, based on 1949 price level, was calculated in a previous section beginning on page 44. These costs do not include value of grade loss and field waste, considered elsewhere in this publication.
§ It is assumed that 1,350 pounds of seed cotton are required to make a 500-pound gross-weight bale in first picking and 1,500 pounds in second picking. These weights approximate those found in the 1949 survey.

80 per cent of the cotton, or 1.2 bales per acre, is gathered in the first pick. Three-fourths of the acreage is picked a second time and 0.4 bale per acre is harvested on each acre covered. The average costs of picking in the first and second pick are summarized in table 26.

Effect of yield per acre on first and second picking costs. Approximately 80 per cent of the cotton is usually open at the time of the first picking. The pick itself varies with the yield per acre. The first pick in 1949 ranged from 0.6 bale to 2.0 bales per acre.* The second pick ranged from 0.1 to 0.7 bale per acre.

Within those ranges, respectively, costs of first and second picking were estimated (table 27). The relationship between picking costs and *total yield* has been noted previously (see pages 45–46). A similar relationship was found between picking costs and the amount of cotton picked in *each picking*. In first picking, the cost ranges from $8.99 a bale when the pick is 2.0 bales per acre to $12.62 a bale when the pick is 0.8 bale. In second picking, the cost ranges

* One of the interviewed growers picked 2.75 bales (3,585 pounds of seed cotton) per acre of first picking, but that was exceptional.

from $13.67 a bale when the pick is 0.7 bale per acre to $77.40 a bale when the pick is 0.1 bale.

Cost of very light picking or scrapping. Cost of mechanical harvesting in light picking is of economic importance especially in very late second picking. The grower needs to know how much seed cotton per acre he must get to afford machine picking. An analysis was made to provide that information. Costs per 100 pounds of seed cotton were calculated for picks ranging from 50 to 350 pounds per acre (table 28). Costs were first calculated using the total picking cost of $7.37 per hour.

Table 28. Total Cost and Operating Cost in Machine Picking Per Hundredweight of Seed Cotton at Various Picks Per Acre

Pick of seed cotton per acre in pounds	Machine picking cost per 100 pounds of seed cotton*	
	Total cost	Operating cost
50	$15.48	$9.64
100	7.81	4.86
150	5.21	3.24
200	3.94	2.46
250	3.16	1.96
300	2.65	1.65
350	2.27	1.42

* Picking cost does not include value of grade loss and field waste considered elsewhere in this report.

For a pick of 150 pounds per acre, the mechanical picking cost is $5.21 per 100 pounds. With lint at 20 cents a pound (the approximate value of clean-up cotton in recent years) and cotton seed at $45 a ton, 100 pounds of seed cotton is worth about $7.70 after ginning costs of $0.70 are subtracted. Under these conditions, the value of the seed cotton exceeds the cost of mechanical picking, but it would be more economical to employ hand pickers at any rate under $5.21 per 100 pounds. When the pick is 200 pounds an acre, the mechanical picking cost is $3.94 per 100 pounds, which was about the going rate of hand, second picking in 1949. Machine picking, in other words, is more economical than hand picking when the pick is 250 pounds or more per acre; hand picking is cheaper when the pick is less. In these calculations, the effect of machine picking on grade and field waste was not considered.

Some may maintain that operating costs, excluding overhead, should be used for these calculations. They would say that overhead costs should be charged wholly to earlier picking. Accordingly, costs were recalculated using the operating cost of $4.59 per hour in second picking as found in the study. This operating cost amounted to $3.24 per 100 pounds when the pick was 150 pounds of seed cotton per acre. On the basis of operating costs alone, therefore, it is economically feasible to operate a mechanical harvester when the second pick is only 150 pounds an acre.

LATER DEVELOPMENTS IN MECHANICAL COTTON HARVESTERS

The field survey of mechanical harvesters operating in California during 1949 was necessarily limited to a sample of the one-row, drum-spindle make that had been in the process of development and industry acceptance before World War II. During the 1950 harvest three other makes of pickers were operating in the state, and one, referred to as Mechanical Cotton Harvester Number 2, was in wide enough use to permit the random selection of a survey sample.*

* Several makes of spindle-type picking machines became available to California growers between 1950 and 1953. These various makes of machines will continue to improve as additional operating experience is gained, and it is possible that still further makes, possibly embodying new picking principles, will be developed.

Table 29. Average Performance Rates of Mechanical Harvester Number 2, Operated by 18 Growers in the San Joaquin Valley, 1950

Item*	One-row machines	Two-row machines
	pounds	
Seed cotton harvested per machine-hour:		
First picking	695	1,152
Second picking	226	269
All picking	561	821
	bales	
Bales harvested per workday:		
First picking	2.9	6.5
Second picking	0.8	1.1
All picking	2.2	4.1

* Other rates, "Machine-hours operated," "Acres harvested," and "Bales harvested," are found in table 30.

Therefore, data were collected on the 1950 operations for a representative sample of that harvester.

As no additional data were collected from growers using Mechanical Harvester Number 1 in 1950, information on the two makes of pickers is not strictly comparable. Furthermore, a valid comparison between the two makes cannot be made from the data available because the field performance of Mechanical Harvester Number 1 reflected the advantage of several years' operation in increasing numbers under varying conditions. A realistic comparative analysis of various picking machines must await several years' field experience and the expected improvement of the more recent makes.

A comparison can, however, be made of the two models, one-row and two-row, of Harvester Number 2, used in 1950.

Cost of picking with mechanical picker Number 2

Data were obtained on the 1950 operations of 12 one-row and 6 two-row models of Mechanical Harvester Number 2. These machines, particularly the one-row models, operated considerably less time and picked fewer bales of cotton than the average for Mechanical Harvester Number 1 in 1949 (tables 29 and 30, and table 34, page 55). The one-row machines studied in 1950 averaged 39 days and 216 hours of operation and picked 88 bales, or 1,211 hundredweight of seed cotton. Each figure is less than half the comparable value for the 1949 operation of Mechanical Harvester Number 1.

Neither model of Mechanical Harvester Number 2, operating in 1950, is considered directly comparable with make Number 1, operating in 1949; the one-row harvester has smaller capacity, the two-row is self-propelled. Data obtained indicate also that the one-row make Number 2 machines were owned by smaller-scale operators than those owning make Number 1. The 1950 operators in general had fewer acres and bales of cotton to harvest because of reduced acreage under the allotment program.

The available data are included to record the first year's experience in California with Mechanical Harvester Number 2 on any appreciable scale. Approximately 105 of these machines were in

operation in 1950, largely around Fresno, Tulare, and Delano. The results provide a comparison of the two models within the make. The two-row model quite commonly is not operated in first picking to harvest two rows; instead, both picking heads operate in tandem on a single row.

Picking costs per bale for both models were less than half those of hand picking

Table 30. Average Use and Performance of Mechanical Cotton Harvester Number 2, Operated by 18 Growers in the San Joaquin Valley, 1950

Item	Average per grower	
	One-row	Two-row
Number of records	12	6
Operating season:		
Beginning date, average	October 11	October 11
Ending date, average	December 24	December 24
Total elapsed days	75	75
Days operated:		
First picking	27	28
Second picking	12	22
Total	39	50
Machine-hours operated:		
First picking	154	217
Second picking	62	130
Total	216	347
Acres harvested:		
First picking	61	129
Second picking	39	116
Total	100	245
Bales harvested:		
First picking	78	182
Second picking	10	25
Total	88	207
Seed cotton harvested (hundredweight):*		
First picking	1,071	2,499
Second picking	140	350
Total	1,211	2.849

* Estimated on basis of machine-picked lint turnout in 1949 survey.

Table 31. Cost of Picking Cotton with Mechanical Harvester Number 2 in the San Joaquin Valley, 1950

Item	Eastside area (18 growers)							
	One-row				Two-row			
	Season total	Acre	Hour	Bale	Season total	Acre	Hour	Bale
Acres of picking	100	....	0.46	1.14	245	....	0.71	1.18
Machine-hours	216	2.16	....	2.45	347	1.42	....	1.68
Bales harvested	88	0.88	0.41	....	207	0.84	0.60	....
Investment								
Harvester	$4,738	$47.38	$21.93	$53.84	$10,250	$41.84	$29.54	$49.52
Tractor	1,505	15.05	6.97	17.10	.....	.....	.....	.....
Total	$6,243	$62.43	$28.90	$70.94	$10,250	$41.84	$29.54	$49.52
Picking costs								
Overhead:								
Harvester	1,022	10.22	4.73	11.61	2,219	9.06	6.39	10.72
Tractor*	99	0.99	0.46	1.13	.....	.....	.....	.....
Total	$ 1,121	$ 11.21	$ 5.19	$ 12.74	$ 2,219	$ 9.06	$ 6.39	$10.72
Operation:								
Harvester	581	5.81	2.69	6.60	1,140	4.65	3.29	5.50
Tractor†	74	0.74	0.34	0.84	206	0.84	0.59	1.00
Total	$ 655	$ 6.55	$ .303	$ 7.44	$1,346	$ 5.49	$ 3.88	$ 6.50
Labor:								
Operating	222	2.22	1.03	2.52	393	1.61	1.13	1.90
Service and repair	98	0.98	0.46	1.11	170	0.69	0.49	0.82
Farm shop	29	0.29	0.13	0.33	50	0.20	0.15	0.24
Compensation	5	0.05	0.02	0.06	7	0.30	0.02	0.04
Total	$ 354	$ 3.54	$ 1.64	$ 4.02	$ 620	$ 2.53	$ 1.79	$ 3.00
Total costs	$2,130	$21.30	$ 9.86	$24.20	$4,185	$17.08	$12.06	$20.22
Labor used (man-hours):								
Operating	216	2.16	1.00	2.45	347	1.42	1.00	1.68
Other	154	1.54	0.71	1.75	210	0.86	0.60	1.01
Total	370	3.70	1.71	4.20	557	2.28	1.60	2.69

* Share of annual overhead (including repairs) charged to cotton harvesting as tractors were used in other farm work at other seasons of the year except that two-row harvester is integrated machine not mounted on tractor.

† On harvesting cotton only; does not include repair costs which were included in overhead for convenience in prorating the share charged to harvesting cotton. Also see above footnote.

Table 32. Summary of Picking Costs per 100 Pounds of Seed Cotton for Mechanical Harvester Number 2, 1950

	One-row machine*	Two-row machine†
First picking	$1.42	$1.05
Second picking	4.36	4.48
All picking	1.76	1.47

* This cost covers overhead, operation of equipment, and labor, a total of $9.86 per operating hour. See tables 38 and 39, pages 61–62, for detail of items included.
† This cost covers overhead, operation of equipment, and labor, a total of $12.06 per operating hour. See tables 38 and 39, pages 61–62, for detail of items included.

(table 31). The costs were $4.00 per bale cheaper in 1950 for the two-row, larger capacity machine.

Picking costs per 100 pounds of seed cotton were $1.47 for the two-row machine, 16 per cent lower than for the one-row. A summary of picking costs per 100 pounds of cotton by first and second pickings and for the season are summarized in table 32.

APPENDIX

How farmers were selected for interview

From information supplied by harvester dealers, a list was prepared of all persons known to own mechanical pickers in the San Joaquin Valley in 1949. About 400 farmers owned one harvester each, 75 owned two each, and 50 owned three or more. Only those farmers who owned one picker were interviewed, as it was felt that they represented the most typical situation and would be better able to provide complete information about individual machines. Owners whose operations were mainly custom work for others were excluded, insofar as possible, because such farmers are less typical. The harvester dealers helped edit the list to exclude such custom operators. Thus, the original list was limited to farmers with one mechanical picker used primarily to pick their own cotton.

Owners in the revised list were then sorted into five geographical subareas (fig. 2). From the list for each area, a sample was selected for interview. Selection was on the basis of every *n*th name; in some areas this meant every fourth name; in others, every sixth. In the Madera-Merced area, it was necessary to include all 14 farmers owning machines to obtain a sufficient sample. The resulting sample included the following number of interviews by subareas:

Kern	15
Eastside	16
San Joaquin-Tranquillity	9
Westside	9
Madera-Merced	14
Total	63

Since the sample was designed to represent the typical situation, it does not *necessarily* represent the arithmetical average. However, it is believed that, from the standpoint of output per machine, cost of picking per bale, and related data, the typical situation would not differ greatly from the over-all average.

ACKNOWLEDGMENTS

Although many people offered helpful suggestions toward planning this study and preparing the report, only a few can be mentioned here. The authors are especially grateful for assistance provided in 1949–1950 by J. P. Fairbank, Regional Director of Agricultural Extension Service, College of Agriculture, Berkeley; Marvin Hoover, Extension Cotton Specialist, Shafter; Ray Provost, Producers Cotton Oil Company; R. V. Jensen, San Joaquin Cotton Oil Company; J. Russell Kennedy, California Cotton Cooperative Association; W. B. Lanham, Cotton Branch, Production and Marketing Administration; the Farm Advisors, Agricultural Extension Service, in Fresno, Kern, Kings, Madera, Merced, and Tulare counties; and the harvester dealer-distributors in the Valley. The authors are appreciative also of the helpful coöperation of the cotton growers who furnished records of their mechanical harvest operation in the 1949 season.

LITERATURE CITED

Archer, R. C.
1948. Progress in the mechanical picking of cotton. Proc., Ind. Ann. Beltwide Cotton Mech. Conf., Lubbock, Texas.

Burlingame, Burt B., and Warren R. Bailey
1950. Cost of harvesting cotton with mechanical pickers—California—1948. California Agr. Ext. Serv. (Mimeo.)

Campbell, John D.
1948. Oklahoma farmers' experience with cotton strippers. Oklahoma Agr. Exp. Sta. Bul. **B-324.**

Crowe, Grady B.
1949*a*. Mechanical cotton picker operation in the Yazoo-Mississippi delta. U. S. Bur. Agr. Econ. Mississippi Agr. Exp. Sta. Prog. Rept.
1949*b*. Mechanical cotton picker operation in the Yazoo-Mississippi delta. Mississippi Agr. Exp. Sta. Bul. **465.**

Holley, William C., and Loyd E. Arnold
1938. Changes in technology and labor requirements in crop production—cotton. Works Progress Administration, National Research Project, **A-7.**

Hoover, Marvin
1949. Cotton mechanization. From Project Report by J. P. Fairbank and K. O. Smith (Project 1361, Dept. of Agricultural Engineering). California Agr. Ext. Serv. (Mimeo.)

Sutherland, J. Gwyn, and H. Brooks James
1948. Mechanical harvesting of cotton in North Carolina, 1947. North Carolina Agr. Exp. Sta. Agricultural Economics Information, Series **20.**

Venstrom, Cruz
1946. Experience in 1945 with mechanical cotton pickers in California. U. S. Bur. Agr. Econ. (Mimeo.)

Williamson, M. N., Jr., Q. M. Morgan, and Ralph H. Rogers
1951. Economics of mechanical cotton harvesting in the high plains cotton area of Texas. Texas Agr. Exp. Sta. Bul. **735.**

Williamson, M. N., Jr., and Ralph H. Rogers
1949. Economics of cotton harvesting, Texas high plains, 1948 season. Texas Agr. Exp. Sta. Prog. Rept. **1200.**

Table 33. Cotton Harvested by 63 Growers in the San Joaquin Valley, 1949, by Method of Harvest

Area	Number of growers	Total harvested	Includes machine custom picking for other growers					
			Both pickings		First picking		Second picking	
			Machine-picked	Hand-picked	Machine-picked	Hand-picked	Machine-picked	Hand-picked
		bales						
San Joaquin Valley...	63*	429	229	200	182	165	47	35
Subareas:								
Kern.....	15†	443	258	185	201	144	57	41
Eastside.....	16	428	245	183	185	156	60	27
San Joaquin–Tranquillity.....	9‡	350	201	149	183	53	18	96
Westside.....	9§	601	292	309	244	278	48	31
Madera–Merced..	14¶	357	158	199	116	170	42	29

Note: Averages are for all growers interviewed whether or not they all used machines or hand pickers in first or second picking.

* Eleven growers had no hand picking; four had no machine first picking; and two had no machine second picking.

† Four growers had no hand picking; three had no machine first picking; and one had no machine second picking.

‡ Two growers had no hand picking; one had no machine second picking.

§ Four growers had no hand picking.

¶ One grower had no hand picking; one grower had no machine first picking.

Table 34. Average Cost of Mechanical Cotton Picking with Harvester Number 1, by Subareas, San Joaquin Valley, 1949

Item	Kern area (15 growers)				Eastside area (16 growers)			
	Season total	Average			Season total	Average		
		per Acre	per Hour	per Bale		per Acre	per Hour	per Bale
Acres of picking	263	....	0.64	1.02	309	....	0.72	1.26
Machine hours	414	1.57	....	1.60	427	1.38	....	1.74
Bales harvested	258	0.98	0.62	....	245	0.79	0.57	....
Investment:								
Harvester	$3,738	$14.21	$ 9.03	$14.49	$3,709	$12.00	$ 8.69	$15.14
Tractor	1,620	6.16	3.91	6.28	1,730	5.60	4.05	7.06
Total	$5,358	$20.37	$12.94	$20.77	$5,439	$17.60	$12.74	$22.20
Picking costs								
Overhead:								
Harvester	1,471	5.59	3.55	5.70	1,410	4.56	3.30	5.75
Tractor	335	1.27	0.81	1.30	306	0.99	0.72	1.25
Total	$1,806	$ 6.86	$ 4.36	$ 7.00	$1,716	$ 5.55	$ 4.02	$ 7.00
Operat'g expenses:								
Harvester	778	2.96	1.88	3.02	1,005	3.25	2.35	4.10
Tractor	156	0.59	0.38	0.60	155	0.50	0.36	0.63
Total	$ 934	$ 3.55	$ 2.26	$ 3.62	$1,160	$ 3.75	$ 2.71	$ 4.73
Labor:								
Operating*	499	1.90	1.20	1.93	495	1.60	1.16	2.02
Service and repair	65	0.25	0.16	0.25	89	0.29	0.21	0.36
Farm shop	11	0.04	0.03	0.04	3	0.01	0.01	0.01
Compensation	6	0.02	0.01	0.02	7	0.02	0.02	0.03
Total	$ 581	$ 2.21	$ 1.40	$ 2.24	$ 594	$ 1.92	$ 1.40	$ 2.42
Total picking costs	$3,321	$12.62	$ 8.02	$12.86	$3,470	$11.22	$ 8.13	$1.415
	man-hours							
Labor used:								
Operating	414	1.57	1.00	1.60	427	1.38	1.00	1.74
Other	91	0.35	0.22	0.35	110	0.36	0.26	0.45
Total	505	1.92	1.22	1.95	537	1.74	1.26	2.19

Continued on next page.
(See end of table for footnotes.)

Table 34. Average Cost of Mechanical Cotton Picking with Harvester Number 1, by Subareas, San Joaquin Valley, 1949—(*Continued*)

Item	San Joaquin-Tranquillity area (9 growers)				Westside area (9 growers)			
	Season total	Average			Season total	Average		
		per Acre	per Hour	per Bale		per Acre	per Hour	per Bale
Acres of picking	273	.....	0.86	1.36	317	....	0.66	1.08
Machine hours	316	1.16	....	1.57	479	1.51	....	1.64
Bales harvested	201	0.74	0.64	....	292	0.92	0.61	....
Investment								
Harvester	$3,729	$13.66	$11.80	$18.55	$3,672	$11.58	$ 7.67	$12.58
Tractor	1,678	6.15	5.31	8.35	1,653	5.22	3.45	5.66
Total	$5,407	$19.81	$17.11	$26.90	$5,325	$16.80	$11.12	$18.24
Picking costs								
Overhead:								
Harvester	1,421	5.21	4.50	7.07	1,349	4.26	2.82	4.62
Tractor	239	0.88	0.76	1.19	312	0.98	0.65	1.07
Total	$1,660	$ 6.09	$ 5.26	$ 8.26	$1,661	$5.24	$ 3.47	$ 5.69
Operating expenses								
Harvester	879	3.22	2.78	4.37	815	2.57	1.70	2.79
Tractor	120	0.44	0.38	0.60	173	0.55	0.36	0.59
Total	$ 999	$ 3.66	$ 3.16	$ 4.97	$ 988	$ 3.12	$ 2.06	$ 3.38
Labor:								
Operating*	444	1.62	1.41	2.21	660	2.09	1.38	2.26
Service and repair	61	0.22	0.19	0.30	103	0.32	0.22	0.35
Farm shop	†	†	†	†	†	†	†	†
Compensation	6	0.02	0.02	0.03	9	0.03	0.02	0.03
Total	$ 511	$ 1.86	$ 1.62	$ 2.54	$ 772	$ 2.44	$ 1.62	$ 2.64
Total picking costs	$3,170	$11.61	$10.04	$15.77	$3,421	$10.80	$ 7.15	$11.71
	man-hours							
Labor used:								
Operating	316	1.16	1.00	1.57	479	1.51	1.00	1.64
Other	66	0.24	0.21	0.33	117	0.37	0.24	0.40
Total	382	1.40	1.21	1.90	596	1.88	1.24	2.04

Continued on next page.
(See end of table for footnotes.)

Table 34. Average Cost of Mechanical Cotton Picking with Harvester Number 1, by Subareas, San Joaquin Valley, 1949—(*Continued*)

Item	Madera–Merced area (14 growers)			
	Season total	Average		
		per Acre	per Hour	per Bale
Acres of picking	265	....	0.66	1.68
Machine hours	387	1.46	....	2.45
Bales harvested	158	0.60	0.40	....
Investment:				
Harvester	$ 3,712	$ 14.01	$ 9.59	$ 23.49
Tractor	1,779	6.71	4.60	11.26
Total	$ 5,491	$ 20.72	$ 14.19	$ 34.75
Picking costs				
Overhead:				
Harvester	1,410	5.32	3.64	8.92
Tractor	363	1.37	0.94	2.30
Total	$ 1,773	$ 6.69	$ 4.58	$ 11.22
Operating expenses:				
Harvester	782	2.95	2.02	4.95
Tractor	126	0.48	0.33	0.80
Total	$ 908	$ 3.43	$ 2.35	$ 5.75
Labor:				
Operating*	466	1.75	1.20	2.95
Service and repair	100	0.38	0.26	0.63
Farm shop	20	0.08	0.05	0.13
Compensation	6	0.02	0.02	0.04
Total	$ 592	$ 2.23	$ 1.53	$ 3.75
Total costs	$ 3,273	$ 12.35	$ 8.46	$ 20.72
	man-hours			
Labor used:				
Operating	387	1.46	1.00	2.45
Other	111	0.42	0.29	0.70
Total	498	1.88	1.29	3.15

* Includes bonuses. The following number of growers paid bonuses averaging indicated amounts by subareas: Kern, 7 growers, $208; Eastside, 2 growers, $188; San Joaquin–Tranquillity, 2 growers, $247; Westside, 1 grower, $460; Madera–Merced, 1 grower, $94.

† Less than one-half cent.

Table 35. Usual Mechanical Harvester Investments and Overhead Costs in the San Joaquin Valley, 1949

Item	San Joaquin Valley	Subareas				
		Kern	East-side	San Joaquin–Tranquillity	West-side	Madera–Merced
Number of records	63	15	16	9	9	14
Acres picked*	284	263	309	273	317	265
Machine hours	407	414	427	316	479	387
Bales picked	229	258	245	201	292	158
Investment						
Harvester:						
Original cost:	$ 6,459	$ 6,501	$ 6,450	$ 6,485	$ 6,386	$ 6,455
Less salvage value	969	975	968	973	958	969
Total depreciation	$ 5,490	$ 5,526	$ 5,482	$ 5,512	$ 5,428	$ 5,486
Average investment	3,714	3,738	3,709	3,729	3,672	3,712
Tractor:						
Original cost	2,950	2,817	3,008	2,918	2,874	3,094
Less salvage value	442	422	451	437	431	464
Total depreciation	$ 2,508	$ 2,395	$ 2,557	$ 2,481	$ 2,443	$ 2,630
Average investment	1,696	1,620	1,730	1,678	1,653	1,779
Annual overhead costs						
Harvester:						
Depreciation	1,112	1,123	1,133	1,101	1,093	1,097
Interest on average investment	149	150	148	149	147	149
General property taxes	123	165	106	121	72	132
Insurance	33	33	23	50	37	32
Total	$ 1,417	$ 1,471	$ 1,410	$ 1,421	$ 1,349	$ 1,410
Tractor:						
Depreciation	371	350	393	378	351	376
Interest on average investment	68	65	69	67	66	71
General property taxes	36	45	32	37	20	41
Insurance	15	14	11	22	17	15
Repairs†	100	100	100	100	100	100
Total	$ 590	$ 574	$ 605	$ 604	$ 554	$ 603
Charged to harvesting cotton:						
Per cent of annual	53.7	58.3	50.5	39.5	56.3	60.2
Amount	$317.00	$335.00	$306.00	$239.00	$312.00	$363.00

* One acre picked over one time; same acre is counted twice if picked over second time.
† Included in overhead for convenience in allocating proportionate share to cotton harvesting.

Table 36. Usual Mechanical Harvester Operating Expenses in the San Joaquin Valley, 1949

Item	San Joaquin Valley	Subareas				
		Kern	East-side	San Joaquin–Tran-quillity	West-side	Madera–Merced
Number of records	63	15	16	9	9	14
Acres picked once over*	284	263	309	273	317	265
Machine hours	407	414	427	316	479	387
Bales harvested	229	258	245	201	292	158
Harvester expense:						
Preseason repair	$ 505	$ 398	$ 583	$ 503	$ 503	$ 472
Seasonal repair	196	230	240	145	145	173
Mount, dismount	79	69	91	119	63	61
Spindle oil	58	49	63	92	62	40
Grease	6	6	8	5	6	7
Wetting agent	25	26	20	15	36	29
Total	$ 869	$ 778	$ 1,005	$ 879	$ 815	$ 782
Tractor expense:†						
Fuel	133	143	140	107	159	113
Oil	8	7	9	7	8	7
Oil filter	4	4	4	4	4	4
Gear grease	2	2	2	2	2	2
Total	$ 147	$ 156	$ 155	$ 120	$ 173	$ 126
Labor expense:						
Operating	460	402	472	388	608	459
Bonus‡	46	97	23	55	51	7
Service and repair	84	65	89	61	103	100
Farm shop	8	11	3	1	1	20
Compensation insurance	7	6	7	6	9	6
Total	$ 605	$ 581	$ 594	$ 511	$ 772	$ 592
Total expenses	$ 1,621	$ 1,515	$ 1,754	$ 1,510	$ 1,760	$ 1,500

* One acre picked over one time; same acre is counted twice if picked over second time.

† Includes only operating costs in harvesting cotton. Repair costs were included in overhead for convenience in prorating share charged to harvesting cotton.

‡ The following number of growers paid bonuses averaging the indicated amounts, by subareas: Kern, 7 growers, $208; Eastside, 2 growers, $188; San Joaquin–Tranquillity, 2 growers, $247; Westside, 1 grower, $460; Merced–Madera, 1 grower, $94.

Table 37. Materials and Labor Used in Harvesting Cotton Mechanically, San Joaquin Valley, 1949

Item	San Joaquin Valley	Subareas				
		Kern	East-side	San Joaquin–Tranquillity	West-side	Madera–Merced
Number of records	63	15	16	9	9	14
Harvester:						
Spindle oil, gallons	107	93	126	144	109	75
Wetting agent, gallons	5	5	4	3	6	5
Grease, pounds	42	41	41	35	38	49
Tractor:						
Fuel, gallons	809	817	836	667	979	750
Cylinder oil, quarts	44	39	53	42	47	38
Oil filters	4	4	4	4	6	4
Grease, pounds	13	13	13	13	13	13
Labor:						
Operating, hours	407	414	427	316	479	387
Service and repair, hours	75	66	84	48	86	86
Mount and dismount,* hours	26	25	27	18	31	25
Farm shop, hours	9	11	6	1	1	18
Total labor, hours	517	516	544	383	597	516

*Average for cases reporting.

Table 38. Investment and Overhead Costs for Mechanical Harvester Number 2, San Joaquin Valley, 1950

Item	Average per grower	
	One-row	Two-row
Number of records	12	6
Acres picked*	100	245
Machine hours	216	347
Bales picked	88	207
Investment		
Harvester:		
Original cost	$ 4,738	$ 10,250
Less salvage value	711	1,538
Total depreciation	$ 4,027	$ 8,712
Average investment	2,724	5,894
Tractor:		
Original cost	1,505	.....
Less salvage value	226	.....
Total depreciation	$ 1,279	.....
Average investment	865	.....
Annual overhead costs		
Harvester:		
Depreciation	805	1,742
Interest on average investment	109	236
General property taxes	75	164
Insurance	33	77
Total	$ 1,022	$ 2,219
Tractor:		
Depreciation	182	
Interest on average investment	35	(single-unit
General property taxes	24	machine, in-
Insurance	10	cluded with
Repairs†	69	above)
Total	$ 320	
Charged to cotton harvesting:		
Per cent of annual	30.9	
Amount	$ 99.00	

* One acre picked over one time; same acre is counted twice if picked over second time.
† Included in overhead for convenience in allocating proportionate share to cotton harvesting.

Table 39. Usual Operating Expense for Mechanical Harvester Number 2, San Joaquin Valley, 1950

Item	Average per grower	
	One-row	Two-row
Number of records	12	6
Acres picked*	100	245
Machine hours	216	347
Bales harvested	88	207
Harvester expenses:		
Preseason repair	$ 284	$ 273
Seasonal repair	153	607
Mount and dismount	45	.....
Graphite and carbon tet.	8	26
Grease	3	6
Wetting agent	88	228
Total	$ 581	$ 1,140
Tractor expense:†		
Fuel	62	199
Oil	5	4
Oil filter	3	3
Gear grease	4	.....
Total	$ 74	$ 206
Labor expense:		
Operating	222	361
Bonus	.....	32
Service and repair	98	170
Farm shop	29	50
Compensation insurance	5	7
Total	$ 354	$ 620
Total expenses	$ 1,009	$ 1,966

* One acre picked over one time; same acre is counted twice if picked over second time.
† Maintenance and repair costs were estimated on an annual basis and included in overhead for convenience in prorating the share charged to harvesting cotton.

Table 40. Usual Materials and Labor Used in Harvesting Cotton with Mechanical Harvester Number 2, San Joaquin Valley, 1950

Item	Average per machine	
	One-row	Two-row
Number of records	12	6
Harvester:		
Wetting agent, gallons	14	36
Grease, pounds	20	47
Tractor		
Fuel, gallons	359	1,104
Cylinder oil, quarts	32	27
Oil filters	3	4
Grease, pounds	27	....
Labor:		
Operating, hours	216	347
Service and repair, hours	96	162
Mount and dismount, hours	29	....
Farm shop, hours	29	48
Total hours	370	557

Table 41. Grades of Machine- and Hand-Picked Cotton in the San Joaquin Valley, 1949; Frequency Distribution of Bales by Grade and Color, 35 Gins, by Subareas

Grade*	San Joaquin Valley 35 gins		Subareas									
			Kern (8 gins)		Eastside (9 gins)		San Joaquin–Tranquillity (2 gins)		Westside (12 gins)		Madera–Merced (4 gins)	
	Machine-picked	Hand-picked	Machine-picked	Hand-picked	Machine-picked	Hand-picked	Machine-picked	Hand-picked	Machine-picked	Hand-picked	Machine-picked	Hand-picked
	number of bales											
White and extra white												
GM	64	5,771	48	4,410	.....	587	.....	34	16	738	.....	2
SM	1,474	55,858	518	16,230	93	16,791	27	2,653	831	18,350	5	1,834
M	11,559	86,929	3,067	15,078	1,153	23,059	433	5,221	6,824	36,161	82	7,410
SLM	27,431	52,134	7,090	8,583	5,002	15,872	2,012	2,826	12,611	21,033	716	3,820
LM	13,284	13,874	2,869	1,600	3,856	4,311	901	903	4,655	4,719	1,003	2,341
SGO	2,658	3,244	399	868	652	782	444	213	645	941	518	440
GO	538	1,174	88	229	245	343	23	274	130	216	52	112
Spotted												
GM	25	268	25	130	.....	59	.....	12	.....	27	.....	40
SM	600	3,530	422	846	22	1,426	16	182	134	454	6	622
M	1,301	3,943	605	396	51	1,676	62	185	514	530	69	1,156
SLM	694	1,080	255	124	29	363	15	27	256	176	139	390
LM	177	968	65	224	.....	283	.....	77	91	151	21	233
Tinged												
GM	.....	1	.....	.....	.....	1	.....	.....	.....	.....	.....	.....
SM	.....	7	.....	.....	.....	5	.....	.....	.....	.....	.....	2
M	.....	263	.....	242	.....	20	.....	.....	.....	1	.....	.....
SLM	.....	51	.....	23	.....	11	.....	1	.....	1	.....	15
LM	.....	32	.....	4	.....	4	.....	5	.....	.....	.....	19
Gray												
GM	12	112	12	107	.....	.....	.....	1	.....	4	.....	.....
SM	435	967	349	365	26	168	5	211	55	160	.....	63
M	1,495	5,852	650	711	136	1,888	448	1,008	261	1,430	.....	817
SLM	683	1,364	194	64	83	399	227	284	168	344	11	273
Below grade	193	389	65	95	73	155	.....	63	41	10	14	66
Total	62,623	237,811	16,721	50,329	11,421	68,203	4,613	14,178	27,232	85,446	2,636	19,655
Average grade index	91.8	97.4	92.4	98.9	89.6	97.2	89.1	95.4	93.3	97.7	85.8	94.4
Average loan value	$132.52	$142.84	$133.94	$144.79	$127.67	$142.39	$127.97	$139.65	$135.65	$143.96	$117.20	$136.95

* GM = Good Middling, SM = Strict Middling, M = Middling, SLM = Strict Low Middling, LM = Low Middling, SGO = Strict Good Ordinary, GO = Good Ordinary.

Table 42. Grades of Machine- and Hand-Picked Cotton in the San Joaquin Valley, 1949; Percentage Distribution of Bales by Grades and Color, 35 Gins, by Subareas

Grade*	San Joaquin Valley		Subareas									
			Kern		Eastside		San Joaquin–Tranquillity		Westside		Madera–Merced	
	Machine-picked	Hand-picked	Machine-picked	Hand-picked	Machine-picked	Hand-picked	Machine-picked	Hand-picked	Machine-picked	Hand-picked	Machine-picked	Hand-picked
	per cent											
White and extra white												
GM	0.1	2.4	0.3	8.8	....	0.9	....	0.2	0.1	0.9	....	....
SM	2.4	23.5	3.1	32.2	0.8	24.6	0.6	18.7	3.0	21.5	0.2	9.3
M	18.4	36.6	18.3	30.0	10.1	33.8	9.4	36.9	25.0	42.3	3.1	37.7
SLM	43.8	21.9	42.4	17.1	43.9	23.3	43.7	20.0	46.3	24.6	27.2	19.4
LM	21.2	5.8	17.2	3.2	33.8	6.3	19.6	6.4	17.1	5.5	38.0	11.9
SGO	4.2	1.4	2.4	1.7	5.7	1.2	9.6	1.5	2.4	1.1	19.7	2.2
GO	0.9	0.5	0.5	0.5	2.1	0.5	0.5	1.9	0.5	0.3	2.0	0.6
Total	91.0	92.1	84.2	93.5	96.4	90.6	83.4	85.6	94.4	96.2	90.2	81.1
Spotted												
GM	....	0.1	0.1	0.3	....	0.1	....	0.1	....	....	....	0.2
SM	1.0	1.5	2.5	1.7	0.2	2.1	0.3	1.3	0.5	0.5	0.2	3.2
M	2.1	1.7	3.6	0.8	0.4	2.5	1.3	1.3	1.9	0.6	2.6	5.9
SLM	1.1	0.4	1.5	0.2	0.3	0.5	0.3	0.2	0.9	0.2	5.3	2.0
LM	0.3	0.4	0.4	0.4	....	0.4	....	0.5	0.3	0.2	0.8	1.2
Total	4.5	4.1	8.1	3.4	0.9	5.6	1.9	3.4	3.6	1.5	8.9	12.5
Tinged												
GM	....	....	....	....	....	....	....	....	....	....	....	....
SM	....	....	....	....	....	....	....	....	....	....	....	....
M	....	0.1	....	0.5	....	....	....	....	....	....	....	....
SLM	....	....	....	....	....	....	....	....	....	....	....	0.1
LM	....	....	....	....	....	....	....	....	....	....	....	0.1
Total	....	0.1	....	0.5	....	....	....	....	....	....	....	0.2
Gray												
GM	....	....	0.1	0.2	....	....	....	....	....	....	....	....
SM	0.7	0.4	2.1	0.7	0.2	0.2	0.1	1.5	0.2	0.2	....	0.3
M	2.4	2.5	3.9	1.4	1.2	2.8	9.7	7.1	1.0	1.7	....	4.2
SLM	1.1	0.6	1.2	0.1	0.7	0.6	4.9	2.0	0.6	0.4	0.4	1.4
Total	4.2	3.5	7.3	2.4	2.1	3.6	14.7	10.6	1.8	2.3	0.4	5.9
Below grade	0.3	0.2	0.4	0.2	0.6	0.2	....	0.4	0.2	....	0.5	0.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* See footnote in table 41.

Table 43. Weekly Grade Indexes and Differentials for Machine- Versus Hand-Picked Cotton in the San Joaquin Valley, 1949; Eight Selected Gins

Week of harvest season*	Machine-picked	Hand-picked	Difference†	Machine-picked	Hand-picked	Difference†	Machine-picked	Hand-picked	Difference†
	Gin N-1			Gin W-3			Gin W-4		
1st	....	....	....	....	....	....	....	....	....
2d	....	100.8	....	....	102.0	....	95.8	104.3	−8.5
3d	....	100.7	....	93.6	104.1	−10.5	99.2	104.8	−5.6
4th	....	99.5	....	100.6	103.9	−3.3	97.1	103.8	−6.7
5th	93.6	100.1	−6.5	96.3	103.7	−7.4	98.9	103.3	−4.4
6th	93.1	100.3	−7.2	96.1	103.5	−7.4	99.0	101.3	−2.3
7th	85.3	97.6	−12.3	95.3	102.7	−7.4	96.8	102.3	−5.5
8th	87.5	99.8	−12.3	98.9	102.3	−3.4	96.0	101.8	−5.8
9th	85.4	95.7	−10.3	93.2	99.2	−6.0	94.3	99.7	−5.4
10th	86.7	94.7	−8.0	90.0	96.0	−6.0	95.5	99.3	−3.8
11th	83.5	88.0	−4.5	90.2	95.5	−5.3	(95.5)‡	(98.2)	(−2.7)
12th	79.3	85.9	−6.6	86.0	94.8	−8.8	95.4	97.1	−1.7
13th	(74.2)	83.5	−9.3	88.6	95.4	−6.8	90.1	98.8	−8.7
14th	68.0	84.8	−16.8	81.7	85.5	−3.8	91.9	96.2	−4.3
15th	....	82.9	....	79.9	82.5	−2.6	87.9	95.3	−7.4
16th	....	79.9	....	76.8	85.3	−8.5	86.2	92.3	−6.1
17th	....	78.8	....	76.0	88.1	−12.1	82.1	(90.0)	....
18th	....	83.9	....	....	....	....	....	....	....

	Gin E-5			Gin E-6			Gin S-7		
1st	....	....	....	....	....	....	....	....	....
2d	....	100.6	....	....	102.5	....	....	103.2	....
3d	95.0	101.8	−6.8	....	100.5	....	96.4	96.0	−0.4
4th	97.6	102.2	−4.6	93.3	102.0	−8.7	95.0	103.2	−8.2
5th	92.0	98.9	−6.9	96.1	100.7	− 4.6	94.2	101.2	−7.0
6th	93.2	100.6	−7.4	91.1	102.3	−11.2	92.3	102.5	−10.2
7th	85.4	98.7	−13.3	88.5	100.4	−11.9	92.1	100.4	−8.3
8th	92.4	99.7	−7.3	92.2	99.5	−7.3	93.2	101.3	−8.1
9th	88.4	96.7	−8.3	83.1	96.2	−13.1	94.0	100.9	−6.9
10th	85.5	95.9	−10.4	82.8	94.4	−11.6	88.5	96.6	−8.1
11th	85.0	91.7	−6.7	80.5	93.7	−13.2	86.7	97.4	−10.7
12th	77.3	89.8	−12.5	75.4	92.4	−17.0	85.0	93.8	−8.8
13th	72.6	84.4	−11.8	73.9	91.6	−17.7	76.4	88.9	−12.5
14th	75.0	83.1	−8.1	69.2	86.0	−16.8	81.1	82.5	−1.4
15th	(74.4)	77.4	....	70.2	88.0	−17.8	74.6	80.9	−6.3
16th	73.9	79.6	−5.7	74.2	85.5	−11.3	78.3	86.8	−8.5
17th	(73.8)	78.3	....	79.1	82.6	−3.5	78.9	80.2	−1.3
18th	73.7	76.1	2.4	74.8	....	....	73.9	80.1	−6.2

Continued on next page.
(See end of table for footnotes.)

Table 43. Weekly Grade Indexes and Differentials for Machine- Versus Hand-Picked Cotton—(*Continued*)

Week of harvest season*	Machine-picked	Hand-picked	Difference†	Machine-picked	Hand-picked	Difference†	Machine-picked	Hand-picked	Difference†
	Gin S-8			Gin C-2			Total 8 Gins		
1st	....	102.3	....	....	....	....	....	102.3	....
2d	....	103.9	....	....	....	....	95.8	102.5	−6.7
3d	98.6	103.9	−5.3	....	104.0	....	96.6	102.0	−5.4
4th	96.2	103.2	−7.0	97.1	102.6	−5.5	96.7	102.6	−5.9
5th	94.4	102.4	−8.0	96.1	102.5	−6.4	95.2	101.6	−6.4
6th	95.9	101.3	−5.4	93.5	101.9	−8.4	94.3	101.7	−7.4
7th	94.5	101.4	−6.9	94.0	102.0	−8.0	91.5	100.7	−9.2
8th	94.5	100.5	−6.0	94.1	100.9	−6.8	93.6	100.7	−7.1
9th	93.2	97.8	−4.6	93.4	96.3	−2.9	90.6	97.8	−7.2
10th	89.5	96.4	−6.9	90.0	95.5	−5.5	88.6	96.1	−7.5
11th	92.1	95.4	−3.3	90.2	97.5	−7.3	88.0	94.7	−6.7
12th	93.9	95.5	−1.6	83.6	95.3	−11.7	84.5	93.1	−8.6
13th	91.1	93.6	−2.5	82.0	83.5	−1.5	81.1	90.0	−8.9
14th	89.0	93.3	−4.3	81.6	82.7	−1.1	79.7	86.8	−7.1
15th	89.0	92.2	−3.2	80.3	82.2	−1.9	79.5	85.2	−5.7
16th	87.9	91.2	−3.3	78.7	79.5	−0.8	79.4	85.0	−5.6
17th	88.3	86.0	−2.3	(78.6)	78.8	....	79.5	82.8	−3.3
18th	85.1	82.3	−2.8	78.5	76.6	+1.9	77.2	79.8	−2.6

* First week begins September 11; eighteenth week ends January 14.
† Minus sign indicates machine below hand; plus sign indicates hand below machine.
‡ Figures in parentheses represent interpolation where actual data were missing.

Table 44. Grade Index of Cotton from 51 Selected Farms, by Method of Harvest, San Joaquin Valley, 1949 Season

Area	Number of farms*	Average			Range in farms	
		Machine-picked	Hand-picked	Difference†	Machine-picked	Hand-picked
San Joaquin Valley	51	91.8	95.4	−3.6	83–99	82–103
Subareas:						
Kern	9	95.5	94.3	+ 1.2	89–99	87–103
Eastside	12	89.4	96.7	−7.3	87–94	86–101
San Joaquin–Tranquillity	9	90.2	91.7	−1.4	88–94	88–94
Westside	9	94.7	96.7	−2.0	90–98	94–100
Madera–Merced	12	88.3	95.2	− 6.9	83–95	82–100

* Includes only those interviewed growers for whom the bales could be identified by method of picking.
† Minus sign indicates machine-picked below hand-picked; plus sign, above hand-picked.

Table 45. Grades of Machine- and Hand-Picked Cotton in the San Joaquin Valley, 1948–1950; Percentage Distribution of Bales by Grades, Selected Gins*

Grade†	1948		1949		1950	
	Machine-picked	Hand-picked	Machine-picked	Hand-picked	Machine-picked	Hand-picked
	per cent of bales					
White and extra white						
GM	.....	2.4	0.1	2.4	0.1	2.1
SM	1.8	41.1	2.4	23.5	2.6	23.8
M	17.5	29.7	18.4	36.6	24.2	29.3
SLM	45.5	8.1	43.8	21.9	36.6	11.2
LM	13.1	2.2	21.2	5.8	10.3	4.4
SGO	3.2	1.5	4.2	1.4	3.5	2.8
GO	1.5	0.5	0.9	0.5	1.4	0.9
Total	82.6	85.5	91.0	92.1	78.7	74.5
Spotted						
GM	0.1	0.3	.....	0.1	.....	.....
SM	1.2	3.1	1.0	1.5	0.8	0.1
M	3.4	2.1	2.1	1.7	2.9	0.5
SLM	2.5	1.4	1.1	0.4	1.2	1.0
LM	1.1	2.7	0.3	0.4	0.2	1.1
Total	8.3	9.6	4.5	4.1	5.1	2.7
Tinged						
GM	.....	.....	.....	.....	.....	.....
SM	.....	.....	.....	.....	.....	.....
M	.....	.....	.....	0.1	.....	.....
SLM	.....	.....	.....	.....	.....	.....
LM	.....	.....	.....	.....	.....	.....
Total	.....	.....	.....	0.1	.....	.....
Gray						
GM	0.2	0.3	.....	.....	0.1	0.6
SM	3.4	2.7	0.7	0.4	1.9	5.4
M	2.7	1.4	2.4	2.5	8.0	12.5
SLM	0.2	.....	1.1	0.6	5.2	3.8
Total	6.5	4.4	4.2	3.5	15.2	22.3
Below grade	2.6	0.3	0.3	0.2	1.0	0.4
Total‡	100.0	99.8	100.0	100.0	100.0	99.9

* Data from 22 gins in 1948, 35 in 1949, and 26 in 1950.
† GM = Good Middling, SM = Strict Middling, M = Middling, SLM = Strict Low Middling, LM = Low Middling, SGO = Strict Good Ordinary, GO = Good Ordinary.
‡ Some columns do not add up to 100.0 because of rounding.

Table 46. Grade Indexes Assigned and Government Loan Values of California Cotton, 1949; 1 1/16-inch Staple Upland Cotton by Grades and Colors

Grades	Colors				
	White or extra white	Spotted	Gray	Tinged	Yellow stained
	Indexes*				
Good Middling (GM)	105	101	93	94	86
Strict Good Middling (SGM)	104	99	91	91	81
Middling (M)	100	93	84	82	73
Strict Low Middling (SLM)	94	83	75	75	...
Low Middling (LM)	85	75	...	68	...
Strict Good Ordinary (SGO)	76	...	...	...	...
Good Ordinary (GO)	70	...	...	...	...
(Below grade = 60)					
	1949 Loan values (cents per pound)†				
Good Middling (GM)	30.48	28.33	26.58	21.58	17.98
Strict Good Middling (SGM)	30.33	28.23	26.23	21.28	17.48
Middling (M)	29.83	26.28	25.38	18.43	15.73
Strict Low Middling (SLM)	27.98	20.58	20.18	15.58	.....
Low Middling (LM)	22.88	16.58	.....	13.28	.....
Strict Good Ordinary (SGO)	18.83	.....	.....	.....	.....
Good Ordinary (GO)	16.58	.....	.....	.....	.....
(Below grade)‡					

* As used by the Cotton Branch, Production and Marketing Administration, Bakersfield, California. These indexes are used by the Cotton Branch in its periodic quality reports.

† Computed from Cotton Bulletin 1 and amendments, Commodity Credit Corporation, Production and Marketing Administration, August 16, 1949.

‡ No government loans are made on below-grade bales. In this study, below-grade cotton was assumed to have an average value of 11.84 cents per pound or 1,685 points below Middling White, 15/16-inch staple length.

10m-3,'54(A8635)BEB

Consider YOUR Future in Agricultural Economics

Agricultural economics applies SCIENCE to the BUSINESS OF FARMING . . . to the marketing of farm products, to the use of agricultural and range resources.

If agriculture is to continue as an important segment of our national economy, farmers must be adequately trained in the business of farming. The University of California's course of study in agricultural economics is a step toward that goal.

The curriculum . . . presented on the Davis campus, places major emphasis on Farm Management . . . but also provides instruction in Marketing, Co-operative Marketing, Agricultural Finance, Policy, and related subjects. Supplementary work may also be taken in such branches of agriculture as Agronomy, Animal Husbandry, Pomology, Agricultural Engineering, and the like.

The faculty . . . is comprised of trained, experienced economists, many with national and international reputations in their fields. The staff is active in service and research work in all of the Western States.

Job opportunities . . . can best be understood by pointing to positions now occupied by graduates. The largest percentage are farmers. Other lines of endeavor include:

Farm Managers · Credit work · Farmer Organizations
Marketing Organizations · Agricultural Extension work
State and Federal Departments of Agriculture work
College teaching and research · High school teaching

For more information: Write to the Department of Agricultural Economics, University of California, Davis.

or: See your University of California Farm Advisor for college entrance requirements.